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A major purpose of the Technical Information Center is to provide the broadest dissemination possible of information contained in DOE's Research and Development Reports to business, industry, the academic community, and federal, state and local governments.

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ORNL/EIS--154-Vol.6

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Information Resources Organization

NUCLEAR FACILITY DECOMMISSIONING AND SITE REMEDIAL ACTIONS

A SELECTED BIBLIOGRAPHY
Volume 6

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Remedial Action Program Information Center
Information Research and Analysis

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ABSTRACT

This bibliography of 683 references with abstracts on the subject of nuclear facility decommissioning, uranium mill tailings management, and site remedial actions is the sixth in a series of annual reports prepared for the U.S. Department of Energy's Remedial Action Programs. Foreign as well as domestic literature of all types—technical reports, progress reports, journal articles, conference papers, symposium proceedings, theses, books, patents, legislation, and research project descriptions—has been included. The bibliography contains scientific (basic research as well as applied technology), economic, regulatory, and legal literature pertinent to the U.S. Department of Energy's remedial action program. Major chapters are (1) Surplus Facilities Management Program, (2) Nuclear Facilities Decommissioning, (3) Formerly Utilized Sites Remedial Action Program, (4) Facilities Contaminated with Natural Radioactivity, (5) Uranium Mill Tailings Remedial Action Program, (6) Grand Junction Remedial Action Program, (7) Uranium Mill Tailings Management, (8) Technical Measurements Center, and (9) General Remedial Action Program Studies. Chapter sections for chapters 1, 2, 5, and 7 include Design, Planning, and Regulations; Environmental Studies and Site Surveys; Health, Safety, and Biomedical Studies; Decontamination Studies; Dismantlement and Demolition; Site Stabilization and Reclamation; Waste Disposal; Remedial Action Experience; and General Studies. The references within each chapter or section are arranged alphabetically by leading author. References having no individual author are arranged by corporate affiliation or by publication description. Indexes are provided for author, corporate affiliation, title word, publication description, geographic location, and keywords. The appendix contains a list of frequently used acronyms.

This report was generated from a computerized database maintained by the Remedial Action Program Information Center (RAPIC), which exists to provide information support to researchers in the field of remedial action and radioactive waste management. Comprehensive literature searches of the database and further information concerning this project may be obtained by contacting RAPIC at (615) 576-0568 or FTS 626-0568

CONTENTS

INTRODUCTION

The Remedial Action Program Information Center (RAPIC) is jointly funded by the U.S. Department of Energy (DOE) Division of Facility and Site Decommissioning Projects and the Division of Uranium Mill Tailings Projects to provide technical information support to DOE's remedial action program under the sponsorship of the following:

- Surplus Facilities Management Program
  Lead Field Office—DOE Richland Operations Office
  Lead Technical Contractor—UNC Nuclear Industries, Inc., Office of Surplus Facilities Management (OSFM)
- Formerly Utilized Sites Remedial Action Program
  Lead Field Office—DOE Oak Ridge Operations Office
  Lead Technical Contractor—Bechtel National, Inc.
- Uranium Mill Tailings Remedial Action Program
  Lead Field Office—DOE Albuquerque Operations Office
  Lead Technical Contractor—Jacobs Engineering Group, Inc.
- Grand Junction Remedial Action Program
  Lead Field Office—DOE Grand Junction Area Office
  Lead Technical Contractor—Colorado Department of Health
- Technical Measurements Center
  Lead Office—DOE Grand Junction Area Office
  Lead Technical Contractor—Bendix Field Engineering Corporation

The Nuclear Facility Decommissioning and Site Remedial Actions database was developed and is maintained by RAPIC, which is part of the Information Research and Analysis, Information Resources Organization, located at Oak Ridge National Laboratory. RAPIC's communications with DOE's remedial action programs are administratively coordinated through the Office of Surplus Facilities Management, UNC Nuclear Industries, Inc., Richland, Washington.

RAPIC serves as a central clearinghouse for information (derived from both foreign and domestic publications) concerning scientific, regulatory, and socioeconomic aspects of radioactively contaminated facility/site remedial actions These remedial actions encompass such activities as:

- Performing characterization surveys of radioactively contaminated facilities/sites,
- Conducting ongoing security and surveillance programs,
- Performing preventive maintenance actions to ensure containment of radioactivity while awaiting permanent facility disposition,
- Assessing environmental and engineering aspects of proposed remedial action alternatives.
- Drafting detailed remedial action project plans and procedures, and
- Performing remedial actions to make facilities/sites available for restricted or unrestricted use.

This bibliography of 683 references is the sixth in a series to be prepared by RAPIC. Volumes 1 through 5, published annually from 1980 through 1984, have the same title and same subject coverage. Subsequent volumes, incorporating newly identified items of relevance, will be issued on an annual basis. The contents of this publication are stored in a computer-retrievable data file which undergoes periodic updating. It is preferred that researchers use these published bibliographies as their "first-line" reference tool; however, the data file can be accessed through RAPIC for more current literature listings or for a comprehensive subject search of the entire database.

CONTENTS OF THE BIBLIOGRAPHY

The subject matter of this bibliography is presented in nine chapters: Surplus Facilities Management Program, Nuclear Facilities Decommissioning, Formerly Utilized Sites Remedial Action Program, Facilities Contaminated with Natural Radioactivity, Uranium Mill Tailings Remedial Action Program, Grand Junction Remedial Action Program, Uranium Mill Tailings Management, Technical Measurements Center, and General Remedial Action Program Studies.

The Surplus Facilities Management Program (SFMP) chapter contains references pertaining to the SFMP, program sites (located primarily on federal reservations), and specific D&D technology developed by the program.

The nuclear facilities decommissioning chapter contains foreign D&D information as well as any D&D technology and domestic site-specific information that is not a part of the SFMP.

The Formerly Utilized Sites Remedial Action Program (FUSRAP) chapter contains references pertinent to FUSRAP management or to FUSRAP sites. These sites were used by the Manhattan Engineer District or by the Atomic Energy Commission from the 1940s through the 1960s for the processing, handling, storage, or shipment of radioactive materials.

The chapter on facilities contaminated with natural radioactivity contains information detailing remedial action work at industrial or research facilities (other than at FUSRAP sites) that are contaminated with naturally occurring radioactive materials.

The Uranium Mill Tailings Remedial Action Program (UMTRAP) chapter contains information pertinent to UMTRAP management or to approximately 25 UMTRAP sites, located primarily in the western United States. These sites are inactive uranium milling sites that were operated under government contract.

The Grand Junction Remedial Action Program chapter contains information pertinent to the remedial actions that are under way in Grand Junction, Colorado. This program is concerned with local structures that have in, under, or adjacent to their walls or foundations uranium mill tailings that originated from the Grand Junction uranium tailings pile.

The chapter on uranium mill tailings management contains foreign site-specific information, as well as any basic or applied research and domestic site-specific mill tailings information that is not part of UMTRA.

The Technical Measurements Center chapter contains reports published by the Technical Measurements Center (TMC) Grand Junction, Colorado, on the subject of detection and measurement of radioactive/hazardous contaminants, instrument calibration, and field calibration facilities.

The chapter on general remedial action program studies contains references pertinent to DOE's Division of Facility and Site Decommissioning Projects, Division of Uranium Mill Tailings Projects, or activities associated with two or more of the DOE remedial action programs.

Because of the size and diversity of chapters 1, 2, 5 and 7, it has been necessary to subdivide these chapters into the following sections: Design, Planning, and Regulations; Environmental Studies and Site Surveys; Health, Safety, and Biomedical Studies; Decontamination Studies; Dismantlement and Demolition; Site Stabilization and Reclamation; Waste Disposal; Remedial Action Experience; and General Studies.

INDEXES

It is suggested that readers familiarize themselves with the color-coded indexes, which are essential to finding needed references in this bibliography. The citations are grouped by broad subject categories; thus, locating specific references or groups of references on specific topics requires the use of these indexes. The numbers appearing after each listing in the indexes are citation numbers, which are in ascending order. The author index (pink pages) is organized alphabetically by the last name of each author. All authors listed in a citation are indexed. The corporate affiliation index (blue pages) is an alphabetical listing of the affiliation of all authors indexed. The title word index (yellow pages) is a permuted index of individual title words. A number of title words have been suppressed from this index (e.g., conjunctions, prepositions, articles, and auxiliary verbs, as well as a number of words that frequently appear in document titles on this subject coverage, such as *decommissioning, decontamination, mill, and tailings*). There is a separate listing for each word in the title with the indexed title word appearing at the left margin of the page. The publication description index (green pages) lists alphabetically all report numbers, journal citations, conference descriptions, or other unique document descriptions that would identify the publication. The geographic location index (gold pages) is an alphabetical index of the geographic descriptions of sites referenced in the bibliography. The index is divided into two sections, domestic sites and foreign sites. The keyword index (orange pages) is an alphabetical index of specific terms selected from a controlled thesaurus.

APPENDIX

The appendix lists many of the commonly used acronyms in remedial action and radioactive waste management work.

CITATION FORM

The references within each chapter are arranged alphabetically by first author, corporate affiliation, or publication description of the document. When a personal author is not given for a document, the corporate affiliation will appear first. If these two levels of authorship are not given, the title of the document will appear first. In this situation, the place of the document in the chapter is determined by publication description.

Certain conventions have been established for this bibliography to express superscripts and subscripts:

1. X sub t means X_t or X subscript t.
2. For chemical compounds and elements, NaIO3 (for example) means $NaIO_3$.
3. 10(E+3) or X(E-3) (E denoting exponent) means 10^3 or X^{-3}.
4. Cubic or square dimensions of measurements will be shown as, for example, 6 cu cm for 6 cubic centimeters or 3 sq km for 3 square kilometers.
5. Nuclide mass numbers will be shown as Ra-226, U-238, etc.
6. The following abbreviations have been used in this publication for unit measurements:

A	ampere	l	liter
a	acre	lb	pound
Bq	becquerel	m	meter
C	Celsius	MeV	mega electron volt
c.d.	current density	min	minute
Ci	curie	oz	ounce
cpm	counts per minute	ppm	parts per million
cps	counts per second	R	roentgen
deg	degree	rad	radiation absorbed dose
dpm	disintegrations per minute	rem	roentgen-equivalent-man
dps	disintegrations per second	s	second
F	Fahrenheit	Sv	sievert (dose equivalent)
ft	feet	V	volt
g	gram	W	watt
gal	gallon	W(e)	watt (electrical)
ha	hectare	W(t)	watt (thermal)
hr	hour	WL	working level
in.	inch	yd	yard
keV	kilo electron volt	yr	year

7. The following prefixes have been used to indicate multiples or subdivisions of units of measurement:

a	atto	(10^{-18})	da	deca	(10^{1})
f	femto	(10^{-15})	h	hecto	(10^{2})
p	pico	(10^{-12})	k	kilo	(10^{3})
n	nano	(10^{-9})	M	mega	(10^{6})
u	micro	(10^{-6})	G	giga	(10^{9})
m	milli	(10^{-3})	T	tera	(10^{12})
c	centi	(10^{-2})	P	peta	(10^{15})
d	deci	(10^{-1})	E	exa	(10^{18})

SERVICES

RAPIC provides information support to a large number of researchers involved in the field of remedial action and radioactive waste management. Services such as performing topical searches of RAPIC databases, performing computerized literature searches of the commercially available databases, and providing assistance in locating hardcopies of documents referenced in the bibliography are provided free of charge to the U.S. DOE's Remedial Action Program staff and their subcontractors. Copies of most documents referenced in this bibliography can be obtained through either the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, or the Office of Scientific and Technical Information, U.S. Department of Energy, P.O. Box 62, Oak Ridge, Tennessee 37831.

All inquiries for information services should be addressed to:

Remedial Action Program Information Center
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or
FTS 624-7764 [(615)574-7764]

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Jean Kyriazis and staff from the Office of Surplus Facilities Management (OSFM), UNC Nuclear Industries, Inc., Richland, Washington, provided project guidance, contributed documents, and made many helpful suggestions for the preparation of this report.

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We appreciate the time that Tim Myrick and Thomas Burwinkle, Operations Division, and Clarence Wodtke, Plant and Equipment Division, contributed in reviewing this report.

SAMPLE REFERENCE

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

1-Chapter Heading
2-Section Heading
3-Record Number
(Sequential Number of Reference)
4-Author(s)
5-Corporate Affiliation
6-Document Title
7- Publication Description
8-Publication Date
9-Abstract
10-Abstract Credit

CHAPTER 2. [1]NUCLEAR FACILITIES DECOMMISSIONING
[2]DESIGN, PLANNING, AND REGULATIONS

[3]**191**
[4]Anderson, R.C., and D. T. Dexheimer
[5]Bechtel Power Corporation, San Francisco, CA

[6]**Incorporating Decommissioning Requirements into the Design Process for Nuclear Power Plants**

[7]CONF-800359; Decommissioning Requirements in the Design of Nuclear Facilities, Proceedings of a Nuclear Energy Agency Specialist Meeting, Paris, France, March 17-19, 1980 (pp. 123-134), 285 pp. [8](1980)

[9]As a first step in incorporating decommissioning requirements into the design process, greater effort should be made to optimize designs and select alternatives to facilitate decommissioning without adding to the initial cost of the plant. In this regard, the concept of designing to minimize the plant's bulk quantities of concrete, piping and electrical cables offers a significant opportunity to make the ultimate decommissioning easier. A major design objective should be to build "smaller and lighter" to facilitate decommissioning through the simple reduction of the amount of equipment and structures requiring decontamination, dismantlement, demolition, and disposal. (JMF)[10]

Chapter 1

SURPLUS FACILITIES MANAGEMENT PROGRAM

- Design, Planning, and Regulations
- Environmental Studies and Site Surveys
- Health, Safety, and Biomedical Studies
- Decontamination Studies
- Dismantlement and Demolition
- Site Stabilization and Reclamation
- Waste Disposal
- Remedial Action Experience
- General Studies

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

1

Adams, J.A., E.M. Greager, and M.C. Hughes, UNC Nuclear Industries, Inc., Richland, WA

Action Description Memorandum Decommissioning of the Shut-Down Hanford 100 Area Reactors

UNI-2983; 31 pp. (1984, September 1)

The U.S. Department of Energy, Richland Operations Office (DOE-RL) proposes to decommission the eight shut-down production reactors located in the 100 Areas of the Hanford Site, Richland, Washington. They are the 105-B, -C, -D, -DR, -F, -H, -KE and -KW reactors. A ninth reactor, N Reactor was started in 1963 and is still in operation. The decommissioning of N Reactor is not within the scope of this action. No long-term beneficial use has been identified for the shut-down reactor facilities. Short-term use of the 105-KE and 105-KW reactor fuel storage basins is required for storage of N Reactor fuel. The fuel should be removed by 1987, after which the basins will be decontaminated and kept in standby condition until final disposition. The remaining reactor facilities were deactivated during the period 1964 to 1971 and have since been kept in a safe storage condition. Safe storage for the reactors has consisted of short-term fixes adequate to protect the environment, but not to assure stabilized, long-term storage. The reactors are all contaminated to some degree with low levels of radioactivity. In compliance with the National Environmental Policy Act (NEPA) of 1969 (Council on Environmental Quality 1978), and the DOE-Environmental Compliance Guide 1981, this Action Description Memorandum (ADM) has been prepared to provide environmental input into the decision making process.

2

Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Addendum to the Engineering Evaluation of Alternatives for the Disposition of the Weldon Spring Raffinate Pits Site

DOE/OR/20722-5 (Addendum) (1985, April)

This document is an addendum to the Engineering Evaluation of Alternatives for the Disposition of the Weldon Spring Raffinate Pits Site (EEA), for the Weldon Spring, Missouri, U.S. Department of Energy Surplus Facilities Management Program site. The purposes of this addendum are: (1) to evaluate variations, or subalternatives, of the EEA Alternatives 3 and 4 that address the stabilization of the wastes at the Weldon Spring Raffinate Pits (WSRP) Site, the Weldon Spring Quarry (WSQ), the vicinity properties, and possibly the Weldon Spring Chemical Plant (WSCP); and (2) to evaluate a new alternative that considers reprocessing the raffinates for additional uranium removal. The various subalternatives and the new alternative were developed in response to comments from the Missouri state agencies and other reviewers of the EEA. The assessment of the six variations of alternatives previously evaluated in the EEA and the new alternative presented in this addendum consisted of comparing them on the bases of engineering requirements, maintenance and surveillance requirements, cost, schedule, manpower requirements, and occupational radiation exposure. (Auth)

3

Crimi, F.P., General Electric Company, Shippingport Project, Shippingport Atomic Power Station, Shippingport, PA

Planning the Decommissioning of Shippingport

Nuclear Engineering International 29(361):21-23 (1984, October)

Construction of Shippingport began in 1955. The plant went critical in December 1957. It was permanently shut down in October 1982. The "Shippingport Station Decommissioning Project" consists of four stages: (1) preconceptual engineering decommissioning assessment; (2) conceptual engineering baselines; (3) detailed engineering decommissioning plan; and (4) decommissioning operations. The first three stages have been completed. The objectives of the decommissioning operations stage are to place Shippingport in a radiologically safe condition, to demonstrate safe, cost effective dismantlement of a large scale nuclear power plant, and to provide useful data for future decommissioning projects. Key activities during the early phase of decommissioning operations will consist of: (1) bid package preparation; (2) completion of site modifications required before the start of physical decommissioning; (3) initiation of work on long lead time activities; (4) development of detailed work plans and procedures; and (5) establishment of a radiation worker training program. Two features of the project are particularly noteworthy in that there will be no primary system decontamination, and there will be one-piece removal of the reactor pressure vessel. (JWF)

4
Field, F.R., Savannah River Laboratory, Aiken, SC

A Decommissioning Plan for the Heavy Water Components Test Reactor

DPST-75-417; 96 pp. (1976, January)

Three alternatives to decommission the Heavy Water Components Test Reactor (HWCTR) have been analyzed. The protective confinement approach is advantageous only as long as current activities onsite limit access by the general public; excellent confinement of the residual activity is provided by in situ dry storage as the radiation from Co-60 diminishes. Entombment provides the most secure confinement of the activity but at some increased cost. Dismantling HWCTR has no apparent advantages other than a demonstration at the Savannah River Plant site, because of the long-term commitment to safeguarding radioactive material; the relative cost is high. The induced radioactivity in HWCTR is currently 2.3 X 10(E+4) Ci; general area radiation levels are typically 3 mR/hr. In 35 years, the decay of Co-60 will lower the radiation levels by a factor of 100, and the remaining radioactivity will be 2 X 10(E+3) Ci of Ni-63. Minimal offsite effects are calculated to result after postulated structural failures to the decommissioned HWCTR facility. Flexibility and aesthetics favor dismantlement, but these criteria are considered less significant than public radiation dose, cost, and land area committed. (Auth)(JWF)

5
Hale, V.Q., D.R. Speer, and A.T. MacIntyre, Rockwell Hanford Operations, Richland, WA

Environmental Assessment Relating to the Decommissioning of Strontium Semiworks Facility

DOE/EA-0259; 84 pp. (1985, May)

The Strontium Semiworks Plant consists of 11 facilities which have been retired since 1967 and are currently in a safe storage condition. The physical condition of some of the buildings is marginal and further deterioration will result in added maintenance costs to prevent release of radionuclides to the environment. Due to the potential hazards and continuing costs for surveillance and upkeep, it is proposed that the facility be decommissioned. Alternatives for decommissioning the main process building are: (1) earthen entombment without demolition; (2) partial dismantlement/entombment; (3) razing of all above-ground structures; (4) total dismantlement; and (5) no action. The proposed action is alternative 2 based on stability of the end product, cost of the project and projected impacts. Based on the findings of this Environmental Assessment, the DOE has determined that the proposed action does not constitute a major federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969, U.S. Code 42:4321 et seq. Therefore, an environmental impact statement is not required. (JWF)(PTO)

6
Hudgins, C.

DOE Says Decommissioning on Target Despite Shippingport Increase

Nucleonics Week 26(17):7-8 (1985, April 25)

DOE has increased its cost estimates for dismantling the 72-MW Shippingport reactor from $79.7-million to $98.3-million. The surprise request was contained in a recent budget submittal by DOE to Congress. The cost increase is due primarily to a decision to stretch out the decommissioning program completion date from the third quarter of 1988 to the first quarter of 1990. However, about 5% to 10% of the upward revision was caused by actual cost increases for segments of the program. The decision to stretch out the work was made because DOE had other priorities that needed to be addressed first. (Auth)(CAC)

7
Kennedy, W.E., Jr., and B.A. Napier, Pacific Northwest Laboratory, Richland, WA

Allowable Residual Contamination Levels for Decommissioning, Part 2: A Summary of Example Results

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

PNL-SA-12053; CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 10) (1984, November 6)

This paper contains a description of the results of a study sponsored by UNC Nuclear Industries to determine Allowable Residual Contamination Levels (ARCL) for decommissioning facilities in the 100 Areas of the Hanford Site. ARCL results are presented both for surface contamination remaining in facilities (in dpm/100 sq cm) and for unconfined surface and confined subsurface soil conditions (in pCi/g). Two confined soil conditions are considered: contamination at depths between 1 and 4 m, and contamination at depths greater than or equal to 5 m. A set of worksheets are discussed for modifying the ARCL values to accommodate changes in the radionuclide mixture or concentrations, to consider the impacts of radioactive decay, and to predict instrument responses. Finally, a comparison is made between the unrestricted release ARCL values for the 100 Area facilities and existing decommissioning and land disposal regulations. For surface contamination, the comparison shows good agreement for a selected annual dose limit. For soil contamination, the comparison shows good agreement if reasonable modification factors are applied to account for the differences in modeling soil contamination and licensed low-level waste.

8

Landon, J.L., and R.L. Miller, UNC Nuclear Industries, Inc., Richland, WA; U.S. Department of Energy, Richland Operations Office, Richland, WA

Planning for Decommissioning of the Shippingport Atomic Power Station

UNI-SA-68; 15 pp. (1979, September 7)

Upon termination of operations, Shippingport becomes the responsibility of the Office of Nuclear Waste Management to decommission. Initial decommissioning activities will be concurrent with end-of-life testing and defueling of the reactor. The Decommissioning Assessment, Environmental Assessment, and a draft outline for the EIS have been completed. The results of the assessments are summarized in this paper. In addition, the management of the Shippingport decommissioning project is discussed. (JWF)

9

Myrick, T.E., Oak Ridge National Laboratory, Oak Ridge, TN

The ORNL Surplus Facilities Management Program Long Range Plan

ORNL/TM-8957 (1984, September)

The Long Range Plan was prepared to outline the long-term mangement strategy for ORNL SFMP facilities. It also provides an overview of the ORNL SFMP management structure, specifies the decommissioning criteria to be employed, and identifies special technical problems, research and development needs, and special facilities and equipment that may be required for decommissioning operations. Final disposition of the current inventory of surplus ORNL facilities will require approximately 20 years of dedicated operations. Resource requirements in support of this program are expected to increase in stepwise fashion during the next five years. The total estimated cost (FY 1985 dollars) is $103 million. Continuation of work beyond the scheduled end point would be dependent upon the availability of funds and the addition of projects during the interim years. The waste volume projections for the program point to the significant impacts that decommissioning activities will have on the ORNL waste disposal systems during the next 20 years. Although the annual waste generation rates are not expected to result in any major disruptions of routine activities, the total volume of solid waste, 2.3 X 10(E+4) cu m, represents a significant allocation of the currently available on-site storage and disposal space. (Auth)(ARE)

10

Napier, B.A., and W.E. Kennedy, Jr., Pacific Northwest Laboratory, Richland, WA

Allowable Residual Contamination Levels for Decommissioning, Part 1: A Description of the Method

PNL-SA-12052; CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 12) (198[illegible])

This paper contains a description of the methods used in a study sponsored by UNC Nuclear Industries to deter-

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

mine Allowable Residual Contamination Levels (ARCL) for decommissioning facilities in the 100 Areas of the Hanford Site. The ARCL method is based on a scenario/exposure-pathway analysis and compliance with an annual dose limit for three specific modes of future use of the land and facilities. These modes of use are restricted, controlled, and unrestricted. The information on ARCL values for restricted and controlled use is intended to permit a full consideration of decommissioning alternatives. The analysis results in site-specific ARCL values that can be used for determining compliance with any annual dose limit selected. This flexibility permits proper consideration of field situations involving the radionuclide mixtures and physical conditions encountered. In addition, this method permits a full determination of as low as reasonably achievable (ALARA) conditions.

11

Powers, E.W., and E.A. Wegener, UNC Nuclear Industries, Inc., Richland, WA

Production Reactor Decommissioning Study: 100-F Disposition Plan and Activities Definition

UNI-1002; 96 pp. (1978, April 28)

This report is the third in a series of preparatory documents necessary for accomplishing the ultimate demolition of the 100-F Plutonium Production Reactor and its related facilities. The Disposition Plan and Activities Definition describes the mode to be applied, the end product to be achieved, and the management system to be employed in carrying out the disposition project. The document also identifies the major tasks necessary to accomplish complete dismantlement and demolition of the 100-F Area facilities, and proposes techniques for performing these activities and tasks. Although conceptual, these methods and procedures provide the basis for preparation of the major activity descriptions and detailed work procedure documents. (Auth)(JWF)

12

Rainisch, R., Burns and Roe Industrial Services Corporation, Paramus, NJ

Licensing Assessment: One-Piece Removal of Shippingport Reactor Vessel Internals by Barge

Transactions of the American Nuclear Society 43:573-574; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 573-574) (1982)

The Shippingport Atomic Power Station is located on the Ohio River, approximately 25 miles northwest of Pittsburgh. The plant is a 60-MW(e) pressurized water reactor, operated as a light water breeder reactor by Duquesne Light Company for the U.S. Department of Energy. Commercial operations began in December 1957 and conversion to a breeder was completed in 1976. Shippingport is scheduled to terminate operations in October 1982 and to enter a 2-year period of end-of-life testing and defueling. The decommissioning effort will require the removal, shipment, and offsite disposal of the Station's reactor pressure vessel (RPV) with its internals. A licensing assessment for removing the neutron-activated RPV/internals as a single package and its transport by barge to Richland, Washington, for disposal is presented.

13

Schmidt, D.A., and C.L. Moser, Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID

ICPP BIF Filter Room: Decontamination and Decommissioning Plan

WINCO-1008; 61 pp. (1984, May)

The BIF filter room within the ICPP Fuel Receiving and Storage Facility, CPP-603, has been identified as a high priority item on the INEL Decommissioning and Decontamination (D&D) Long Range Priority List. Decommissioning the BIF Filter Room will: (1) eliminate a potential radiation hazard, (2) eliminate a potential source of contamination, and (3) complete the required remedial action for a facility covered under the DOE Surplus Facilities Management Program's National Plan. This (D&D) plan provides for the disassembly and removal of the entire contents of the BIF filter room, except as noted in Section 5.2.

14

Spence, S.T., UNC Nuclear Industries, Inc., Richland, WA

Updated Project Plan: Shippingport Station Decommissioning Project

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

UNI-2804; 45 pp. (1984. April)

Project plans are the primary documentation used by the DOE Decision Authority to identify the Major System Acquisition Process - Key Decision Points. For the Shippingport Station Decommissioning Project (SSDP), the four key decision points are: approve the mission need, project objective, and the initiation of project activity; approve the selection of the SSDP decommissioning mode; approve the initiation of SSDP decommissioning operations; and approve the release of the Shippingport Station site as safe from a radiation standpoint. The purpose of the SSDP is to place the Shippingport Atomic Power Station in a long-term radiologically safe condition following defueling of the reactor, to perform decommissioning in such a manner as to demonstrate to the nuclear industry the application of decommissioning procedures to a large nuclear power plant, and to provide useful planning data for future decommissioning projects.

15
U.S. Department of Energy, Washington, DC

Record of Decision To Decommission the Shippingport Atomic Power Station

Federal Register 47(161):36276-36278 (1982, August 19)

The U.S. Department of Energy (DOE) has decided to decommission the Shippingport Atomic Power Station, located at Shippingport, Pennsylvania. The station will be decommissioned by immediate dismantlement, following end-of-life testing and defueling of the reactor. DOE considered the following alternatives in reaching its decision to immediately dismantle the station (all of the alternatives are discussed at length in the environmental impact statement): (1) No action - continue operation of the Shippingport Station to produce electricity; (2) No action - close the Shippingport Station while continuing existing security, surveillance, maintenance, and monitoring; (3) No action - close the Shippingport Station and do nothing further; (4) Immediate dismantlement; (5) Safe storage followed by deferred dismantlement; and (6) Entombment. Immediate dismantlement was chosen by DOE and the reasons for the choice are discussed in the Basis for Decision section of this announcement, along with a discussion of the other alternatives. (RCF)(NPK)

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U.S. Department of Energy, Washington, DC

Intent (NOI) To Prepare an Environmental Impact Statement on Decommissioning the Eight Shutdown Production Reactors Located at the Hanford Site near Richland, WA

Federal Register 50(95):20489-20490 (1985, May 16)

The DOE announces its intent to prepare an EIS, in accordance with Section 102(2)(C) of the National Environmental Policy Act (NEPA), to provide environmental input into the decision on the proposed selection and implementation of a decommissioning alternative for the eight shutdown production reactors at the Hanford Site, near Richland, Washington. The purpose of this NOI is to present pertinent background information on the proposed scope and contents of the EIS, and to invite interested agencies, organizations, and members of the general public to submit comments or suggestions for consideration in connection with preparation of the draft EIS. (JWF)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Program Plan FY 1985-1989

SFM-84-2 (Vol. 1) (1984, October)

The Program Plan is the principal control document issued by the U.S. Department of Energy's Surplus Facilities Management Program (SFMP). Volume 1 presents SFMP administrative policies, guidelines, and procedures. Program participants are expected to comply with the requirements and instructions set forth in this document, as well as all referenced regulations, criteria, standards, etc. (Auth)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

Surplus Facilities Management Program Program Plan (Civilian) FY 1985-1989

SFM-84-2 (Vol. 2 - Civilian) (1984, October)

This is the second of three volumes of the Surplus Facilities Management Program (SFMP) FY 1085-1989 Program Plan. This volume outlines the SFMP Civilian Program Work Breakdown Structure, and identifies and describes the tasks/projects currently planned for the accomplishment of SFMP near-term objectives. This volume also includes five appendices of supplemental information on the FY 1985-1989 SFMP Civilian Program budget, project/facility inventory, site descriptions, long-range schedule, and waste volume projects. Volume 1 presents SFMP administrative policies, guidelines, and procedures. Volume 3 addresses the SFMP Defense Program. (Auth)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Program Plan (Defense) FY 1985-1989

SFM-84-2 (Vol. 3 - Defense) (1984, October)

This is the third of three volumes of the Surplus Facilities Management Program (SFMP) FY 1985-1989 Program Plan. This volume outlines the SFMP Defense Program Work Breakdown Structure, and identifies and describes the tasks/projects currently planned for the accomplishment of the SFMP near-term objectives. This volume also includes five appendices of supplemental information on the FY 1985-89 SFMP Defense Program budget, project/facility inventory, site descriptions, long-range schedule, and waste volume projections. Volume 1 present SFMP administrative policies, guidelines, and procedures. Volume 2 addresses the SFMP Civilian Program. (Auth)

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Veluri, V.R., H.J. Moe, M.J. Robinet, and R.A. Wynveen, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL

Development of Site-Specific Soil Cleanup Criteria: New Brunswick Laboratory, New Jersey Site

ANL-OHS/HP-83-200; 59 pp. (1985, March)

The potential human exposure which results from the residual soil radioactivity at a decommissioned site is a prime concern during D&D projects. To estimate this exposure, a pathway analysis approach is often used to arrive at the residual soil radioactivity criteria. The development of such a criteria for the decommissioning of the New Brunswick Laboratory, New Jersey site is discussed. Contamination on this site was spotty and located in small soil pockets spread throughout the site area. Less than 1% of the relevant site area was contaminated. The major contaminants encountered at the site were Pu-239, Am-241, normal and natural uranium, and natural thorium. During the development of the pathway analysis to determine the site cleanup criteria, correction for the inhomogeneity of the contamination was made. These correction factors and their effect upon the relevant pathway parameters are presented. Major pathways by which radioactive material may reach an individual are identified and patterns of use are specified (scenario). Each pathway is modeled to estimate the transfer parameters along the given pathway, such as soil to air to man, etc. The transfer parameters are then combined with dose rate conversion factors (ICRP 30 methodology) to obtain soil concentration to dose rate conversion factors (pCi/g/mrem/yr). For an appropriate choice of annual dose equivalent rate, one can then arrive at a value for the residual factors for the three major pathways; inhalation, ingestion, and external exposure, which are important for the NBL site. (Auth)

21

Williams, R.G., and B.A. Payne, Argonne National Laboratory, Environmental Research Division, Argonne, IL

Critical (Public) Masses: A Case Study of a Radioactive Waste Site

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 33-42) (1985)

Increasing public sensitivity to radioactive and other hazardous waste issues often results in opposition that ranges from presentations by individuals at various public meetings to organizations initiating legal action in the

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DESIGN, PLANNING, AND REGULATIONS

courts. Organized opposition to proposed plans by the U.S. Department of Energy (DOE) for a Surplus Facilities Management Program site near Weldon Spring, Missouri, has emerged during the two years that DOE has been involved in developing plans for this waste management site. An important aspect in the development of the major interest group in this case was the reliance on extra-local expertise at both the state and national levels. The group received organizational strategies, information on radioactive waste, legal advice, and direction from state and local environmental interest groups and various state agencies. The historical development of organized public response and agency response to DOE's plans for the Weldon Spring site is presented in this paper. The role of the interest group has emerged as one of a "watchdog," scrutinizing and evaluating data, publications, and plans. Other organizations now rely on the group as a clearinghouse for information. This case is of particular importance to other waste management projects because it demonstrates the effective use of networking between various interest groups and agencies from the local to the national level. The belief is that the emergence of such groups and their ties with a variety of extra-local organizations will be the rule rather than the exception in future waste projects. Agency personnel and project sponsors will find that an interactive, cooperative approach with such groups is an effective way to resolve waste issues. (Auth)(DCM)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Weldon Spring Site Environmental Monitoring Report, Calendar Year 1983

DOE/OR/20722-16; 45 pp. (1984, June)

During 1983, an environmental monitoring program was continued at the U.S. Department of Energy (DOE) Weldon Spring Site (WSS), located in St. Charles County, Missouri. The monitoring program measures the radon gas content in air, the radium and uranium content of surface water and groundwater, and external radiation levels. The nitrate content of surface water is also measured. Radiation doses to the public from the radioactive residues stored at the site are also calculated. During 1983, site boundary radon concentrations, including radon emanating from naturally occurring sources, were all below the DOE CG limit of 3 pCi/l. Groundwater uranium and radium-226 concentrations within the controlled site areas were all below the DOE CG limits for uncontrolled areas.

23
Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Radiological Survey Report for the Weldon Spring Raffinate Pits Site, Weldon Spring, Missouri

DOE/OR/20722-7; 33 pp. (1984, August)

The Weldon Spring Site (WSS) is a U.S. Department of Energy surplus facility comprising the Raffinate Pits facility, the Quarry, and potentially contaminated vicinity properties. A radiological characterization survey of the Raffinate Pits was conducted in 1982 and 1983 in support of on-site construction work and a technological evaluation of site geology. The survey consisted of direct beta-gamma surface readings, near-surface gamma readings, exposure level measurements, and gamma-log boreholes. Soil samples were also collected from the surface, shallow boreholes, and trenches on the site. This report describes the radiological characterization of the facility, the procedures used to conduct the survey, the survey results, and their significance. (Auth)

24
Bechtel National, Inc., Oak Ridge, TN

Niagara Falls Storage Site Environmental Monitoring Report: Calendar Year 1983

DOE/OR/20722-18; 50 pp. (1984, July)

During 1983, an environmental monitoring program was continued at the Niagara Falls Storage Site, a United States Department of Energy (DOE) surplus facility located in Niagara County, New York presently used for the storage of radioactive residues, contaminated soils and rubble. The monitoring program at NFSS measures radon concentrations in air, uranium and radium concentrations in surface water, groundwater, and sediments, and external gamma exposure rates. Radiation doses to the public are also calculated. Environmental samples collected are analyzed to determine compliance with applicable standards. Comparison of 1983 monitoring results with 1982 results shows a significant decrease in radon levels at almost every monitoring location. External gamma exposure rates also showed a general decrease.

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Bechtel National, Inc., Oak Ridge, TN

Geologic Report for the Weldon Spring Raffinate Pits Site

DOE/OR/20722-6; 216 pp. (1984, November)

A preliminary geologic site characterization study was conducted at the Weldon Spring Raffinate Pits Site, which is part of the Weldon Spring Site, St. Charles County, Missouri. The study determined the following parameters: (1) site stratigraphy; (2) lithology and general conditions of each stratigraphic unit; and (3) groundwater characteristics and their relation to the geology. These parameters were used to evaluate the potential of the site to adequately store low-level radioactive wastes. The site investigation included trenching, geophysical surveying, borehole drilling and sampling, and installing observation wells and piezometers to monitor groundwater and pore pressures. The data collected during this geologic investigation indicate that the Raffinate Pits site is a suitable long-term storage area for the Weldon Spring radioactive wastes. The pit bottoms will be further examined in detail during remedial activities and modified if necessary to assure the continuous presence of a clay with thickness shown by a computer model study to retard and prevent passage of a contaminant front more than 1000 years. (JWF)

26

Berkeley Geosciences Associates, Berkeley, CA

Characterization and Assessment for the Weldon Spring Quarry Low-Level Radioactive Waste Storage Site

DOE/OR-853; 464 pp. (1984, September)

The Weldon Spring Quarry is located approximately four miles from the Weldon Spring Chemical Plant and 20 miles west of St. Louis, MO. Originally a limestone and sand quarry, the nine acre site was later used for the disposal of TNT contaminated soils during the 1940's and the disposal of low-level radioactive waste during the 1960's. The most important potential hazards posed by the quarry are contamination of groundwater, radiation exposure and contamination of trespassers, and contamination of surface waters. The potential for groundwater contamination was identified at an early date by the U.S. Department of Energy (DOE) as the most important of these potential hazards. Particular concern exists for the future of the municipal well field located between the quarry and the Missouri River. At present the well field supplies drinking water for the area from Weldon Spring up to and including parts of the city of St. Charles. As a part of the overall program of assessment and planning for the future of the quarry site, DOE requested Lawrence Berkeley Laboratory (LBL) to perform characterization and assessment work. This work was done in stages in July and August, 1979, July and August, 1980, and February, July, August and September, 1981. In keeping with the initial guidelines provided by the DOE, the general objectives of the LBL work were to: (1) investigate the existing potential hazards posed by the site; (2) develop a capability to predict the potential for migration of radionuclides with the groundwater from the quarry site; and (3) perform a preliminary investigation of the effects of proposed engineering options for the site. The report is broadly organized in two parts covering characterization activities, and modeling for studying the potential for migration under existing conditions as well as under the proposed engineering options. Conclusions and recommendations are presented for the various aspects of the overall study. These aspects include the waste inventory at the site, the results of the geologic and hydrologic studies, the results of the investigations of radionuclide migration from the site, and the results of the modeling studies of engineering options for remedial treatment. (Auth)(CAC)

27

Bettis Atomic Power Laboratory, West Mifflin, PA

Shippingport Atomic Power Station, Technical Progress Report, January 26, 1984-September 30, 1984

WAPD-MRP-162; 9 pp. (1984)

During this report period, activity at the Shippingport Atomic Power Station consisted of defueling operations, shipment of spent fuel to the Expended Core Facility (ECF), and preparations for decommissioning. The remaining eight of the 39 fuel modules were removed from the reactor. These consisted of three blanket modules, and five reflector modules. Shipment of LWBR expended fuel to ECF was completed during this period. The PWR Core 2 lower core barrel was shipped from Shippingport to its burial site on May 8, 1984. Four fuel shipments were received at ECF, unloaded and stored under water. All equipment for the disassembly of spent fuel modules has arrived at ECF and was installed and checked out. The Production Irradiated Fuel Assay Gage, for proof-of-breeding, has been installed in an ECF hot cell and qualified for use. Disassembly of the first core fuel module and removal of the first 10 fuel rods was completed. Nondestructive assay has been performed on these rods. Preparation of the plant for turnover to the decommissioning agency was completed. The plant was turned over to the decommissioning agency on September 6, 1984.

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Boegly, W.J., Jr., Oak Ridge National Laboratory, Oak Ridge, TN

Site Characterization Data for Solid Waste Storage Area 6

ORNL/TM-9442; 112 pp. (1984, December)

Currently, the only operating shallow land burial site for low-level radioactive waste at the Oak Ridge National Laboratory (ORNL) is Solid Waste Storage Area No. 6

(SWSA-6). In 1984, the U.S Department of Energy (DOE) issued Order 5820.2, Radioactive Waste Management, which establishes policies and guidelines by which DOE manages its radioactive waste, waste by-products, and radioactively contaminated surplus facilities. The ORNL Operations Division has given high priority to characterization of SWSA-6 because of the need for continued operation under DOE 5820.2. The purpose of this report is to compile existing information on the geologic and hydrologic conditions in SWSA-6 for use in further studies related to assessing compliance with 5820.2. Burial operations in SWSA-6 began in 1969 on a limited scale, and full operation was initiated in 1973. Since that time, 29,100 cu m of low-level waste containing 251,000 Ci of activity has been buried in SWSA-6. No transuranic waste has been disposed of in SWSA-6; rather this waste is retrievably stored in SWSA-5. Estimates of the remaining usable space in SWSA-6 vary; however, in 1982 sufficient useful land was reported for about 10 more years of operation. Analysis of the information available on SWSA-6 indicates that more information is required to evaluate the surface water hydrology, the geology at depths below the burial trenches, and the nature and extent of soils within the site. Also, a monitoring network will be required to allow detection of potential contaminant movement in groundwater. Although these are the most obvious needs, a number of specific measurements must be made to evaluate the spatial heterogeneity of the site and to provide background information for geohydrological modeling. Some indication of the nature of these measurements is included.

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Owen, R.K., Rockwell International Corporation, Pasadena, CA

Radiological Survey Plan, Suppor of D and D Program Operations - T-024 (SNAP 2 and 10)

DOE/SF/00701-T58; 17 pp. (1976, December 20)

Requirements for radiological survey data in support of the decontamination and disposition of the SNAP facility are described.

30

Roberts, C.M., and C.V. Theis, U.S. Geological Survey, Albuquerque, NM

Preliminary Investigation of Groundwater Occurrences in the Weldon Spring Area, St. Charles County, Missouri: Further Notes on Problems of the Weldon Spring Area, Missouri

USGS-OFR-82-1008; 42 pp. (1983, June)

Groundwater occurrences in the area of Weldon Spring Ordnance Works, Weldon Spring, Missouri, to determine the subsurface conditions controlling its movement as a prerequisite to the location and design of structures contemplated by the U.S. Atomic Energy Commission. (ACR)

31

Ryckman, Edgerley, Tomlinson and Associates, St. Louis, MO

Weldon Spring Chemical Plant Survey and Assessment, Final Report

Report; 79 pp. (1978, June)

A site survey, conducted in the fall of 1977, leads to the conclusion that the present configuration of uranium and thorium material inside equipment and buildings is not a satisfactory method for perpetual storage of those materials. The present configuration requires active maintenance of building shells to prevent entry of rainwater and possible migration of radiological materials into the surrounding environment. Perpetual storage would be more satisfactorily achieved through burial of unrecoverable materials, which requires less active maintenance. The analysis indicates that WSCP must ultimately be decontaminated, however, the present migration of radioactive materials across site boundaries is not extensive enough to require immediate cleanup. The ranking of site disposition alternatives suggests that removal of equipment from buildings and partial decontamination of lands are actions that must inevitably be taken. Buildings could either be decontaminated for restricted or unrestricted use or demolished. Without a future use for the buildings, demolition is an attractive action since it eliminates annual maintenance costs. Complete decontamination of U.S. Department of Army lands without cleaning up the U.S. Department of Energy (DOE) raffinate pits adjacent to WSCP is not an economically effective alternative. Army lands presently serve as a buffer zone surrounding the raffinate pits.

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Complete decontamination of this land leaves the possibility that this land may be recontaminated by the pits at some future date. Therefore, coordination of decontamination actions between the Army and the DOE will be mutually beneficial. (Auth)

32

Schmidt, D.A., and C.L. Moser, Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID

Radiological Characterization and Decision Analysis for the SFE-20 Waste Tank and Vault

WINCO-1021; 37 pp. (1984, September)

Westinghouse Idaho Nuclear Company, Inc. (WINCO), has completed a physical and radiological characterization of the SFE-20 Waste Tank Facility located at the Idaho Chemical Processing Plant (ICPP). The objectives of this characterization are to physically describe the SFE-20 tank and its related components, measure and record radiation fields, determine the radionuclide content of smearable contamination on and about the SFE-20 tank, and determine the radionuclide type and concentration in the tank contents and surface soil above the tank. A decision analysis was performed to select the best method and time frame for decommissioning the SFE-20 Tank, Vault and Pump Pit.

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Seeley, F.G., and A.D. Kelmers, Oak Ridge National Laboratory, Oak Ridge, TN

Geochemical Information for Sites Contaminated with Low-Level Radioactive Wastes: 1 - Niagara Falls Storage Site

ORNL-6083; 137 pp. (1984, November)

The Niagara Falls Storage Site (NFSS) became contaminated from stored radioactive wastes from processing pitchblende ore to recover uranium in the 1940s and 1950s. The U.S. Department of Energy is considering various remedial action options for the NFSS. This report describes the results of geochemical investigations performed to help provide a quantitative evaluation of the effects of various options NFSS soil and groundwater samples were characterized. Uranium and radium sorption ratios and apparent concentration limit values were measured in site soil/groundwater systems by employing batch contact methodology. Near-surface soils were typically lacustrine clay or silty-clay types containing appreciable amounts of dolomite. A core profile changed from sandy loam at the surface to dark clay with chert at the 13.7-m (45-ft) depth just above the underlying red shale bedrock. Radiochemical analysis of the soil core revealed contamination as high as 2600 ug/g for uranium and 8300 pCi/g for Ra-226 at depths near the original site surface. The core profile showed no evidence of downward migration of uranium or radium during the 30-year history of waste storage in the R-10 pile. Lateral migration was not explored. Analysis of groundwater from the soil indicated that it was a dilute sodium/calcium/magnesium sulfate solution, while groundwater from the bedrock was much more concentrated in sodium chloride/sulfate. These analytical differences suggest that there is little vertical mixing between bedrock and soil groundwaters. In general, results from the sorption tests indicated poor uranium sorption behavior in all soil/groundwater systems; maximum sorption ratios ranged from 3.9 to 9.0 l/kg at the lowest uranium solution concentrations tested and decreased to 1 l/kg at higher concentrations. Uranium was very soluble in soil/groundwater systems; the apparent concentration limit was greater than 6 g/l. Very high radium sorption ratios (up to 11,200 l/kg) were obtained. Results of these tests suggest that release of uranium via groundwater migration could be significant because of poor sorption on surrounding soil and high solubility. Solubilized radium would be expected to be effectively retarded by soil at the NFSS. The effects of additives to NFSS soil and ground water samples on the sorption of uranium indicated that the addition of iron compounds increased uranium sorption. (Auth)(DCM)

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Seeley, F.G., and A.D. Kelmers, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN

Geochemical Information for Sites Contaminated with Low-Level Radioactive Wastes: 3 - Weldon Spring Storage Site

ORNL-6112; 56 pp. (1985, February)

The Weldon Spring Storage Site (WSSS), which includes both the chemical site and the quarry, became radioactively contaminated as the result of wastes that were being stored from operations to recover uranium from pitchblende ores in the 1940s and 1950s. The U.S. Department of Energy (DOE) is considering various remedial action options for the WSSS. This report describes the results of geochemical investigations carried out at Oak Ridge National Laboratory (ORNL) to support these activities and to help quantify various remedial action options. Soil and groundwater samples were characterized, and uranium and radium sorption ratios were measured in site soil/groundwater systems by batch contact methodology. Soil samples from various locations around the raffinate pits were found to contain major amounts of silica, along with illite as the primary clay constituent. Particle sizes of the five soil samples were variable (50% distribution point ranging from 12 to 81 microns); the surface areas varied from 13 to 62 sq m/g. Elemental analysis of the samples showed them to be typical of sandy clay and silty clay soils. Groundwater samples included solution from Pit 3 and well water from Well D. Anion analyses showed significant concentrations of sulfate and nitrate (greater than 350 and greater than 7000 mg/l, respectively) in the solution from Pit 3. These anions were also present in the well water, but in lower concentrations. Uranium sorption ratios for four of the soil samples contacted with the solution from Pit 3 were moderate to high (about 300 to about 1000 ml/g). These values indicate that soil at the WSSS may show favorable retardation of uranium and radium in the groundwater. (Auth)(JWF)

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Simpson, D.R., Oak Ridge National Laboratory, Environmental and Occupational Safety Division, Radiation and Safety Surveys Department, Oak Ridge, TN

Preliminary Radiological Characterization Studies of Surplus Reactors and Processing Facilities at ORNL

Health Physics 47(1):128; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

Preliminary radiological characterization studies have recently been made on a number of surplus facilities as part of a major decontamination and decommissioning effort at the Oak Ridge National Laboratory (ORNL) sponsored by the DOE Surplus Facilities Management Program. The Radiation and Safety Surveys (R&SS) Department of the Environmental and Occupational Safety Division (E&OSD) has primary responsibility for carrying out these surveys at reactors, experimental areas, and other processing facilities. These preliminary studies are designed to provide information for the development of long range plans for decommissioning at each site. Information sought in the studies includes: (1) location of contaminated and/or radioactive areas, (2) identification of principal isotopes involved, (3) estimates of radionuclide inventory, (4) evaluation of other safety and/or environmental problems, and (5) identification of areas requiring more detailed study. This paper summarizes the results of eight characterization studies. These include three out-of-service reactors; several experimental areas; an abandoned heat exchanger associated with an operating reactor; a pilot plant for handling fission products; a waste evaporator facility; and a set of shielded shipping casks. Plans to carry out comprehensive radiological and environmental characterizations are discussed. (Auth)(NPK)

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Tsai, S.Y., J.M. Peterson, and M.C.B. Winters, Argonne National Laboratory, Argonne, IL

Analysis of Potential Groundwater Contamination in the Vicinity of the Weldon Spring Raffinate Pits Site, Weldon Spring, Missouri

ANL/ER-84-4; 35 pp. (1984, August)

Results of the analysis of contaminant migration beneath the raffinate pits at the Weldon Spring Raffinate Pits site indicates that during a 10,000-year time period, the maximum concentrations in the water immediately beneath the pit bottoms would be about 4600 pCi/l of radium-226 (Pit 3) and about 12,000 pCi/l of uranium-238 (Pit 1); these concentrations would occur at the centers of the pit bottoms. Based on the assumptions used in this study, the radioactive contaminants in the pits would migrate no more than 2 m (7 ft) below the pit bottoms. Because 6 to 12 m (20 to 40 ft) of silty clays underlie the raffinate pits, the radioactive contaminants would take several tens of thousands of years to reach nearby groundwater supplies. Although the results of these analyses indicate that a high degree of confinement is provided by the four raffinate pits, it should be noted that the validity of such analyses rests on the quality of the parameter values utilized. Due to a lack of current site-specific data for some

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physical parameters, it has been necessary to use historical and regional data for these values. The values cited are at times inconsistent and contradictory, e.g. the wide range of values indicated for the permeability of clays underlying the pits. However, these were the only data available. The analysis reported herein indicates that within the limitations of the available data, use of the Raffinate Pits site for long-term management of radioactive materials such as those currently being stored in the four pits appears to be feasible.

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U.S. Department of Energy, Washington, DC

Announcement of Availability of Draft Environmental Impact Statement, Long-Term Management of Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site and Intent To Conduct Public Hearings

Federal Register 49(166):33706-33707 (1984, August 24)

The U.S. Department of Energy (DOE) has published a draft Environmental Impact Statement (DOE/EIS-0109D), Long-Term Management of Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site, Lewiston, New York. Written comments are invited and three public hearings will be held with respect to the DEIS. Written comments should be received at DOE by October 9, 1984. (JWF)

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U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, DC

Environmental Impact Appraisal for Renewal of Special Nuclear Material License SNM-21 (Docket 70-25)

NUREG-1077; 117 pp. (1984, June)

The proposed action is the renewal of the license necessary for ESG to continue the existing Hot Laboratory operation in Building 020 at the Santa Susana site. The operations at the Headquarters facilities (Buildings 001 and 004) have ceased and the buildings are in the process of decontamination for unrestricted use. The operation of the plutonium R and D facilities (Building 055) at the Santa Susana site have ceased and Building 055 will be decontaminated for unrestricted use. The operations in Building 020 principally consist of the examination of irradiated reactor fuel and the preparation of irradiated Sodium Reactor Experiment (SRE) fuel for eventual reprocessing by removal of the metal cladding and thermal bonding material, cleaning and repackaging of the fuel slugs, and shipment of the fuel for reprocessing. Occasionally, unirradiated fuels are handled in the Hot Laboratory. When such ad hoc situations arise, ESG must receive specific approval from the NRC in the form of a license amendment. The types and amounts of special nuclear material to be handled under the renewed license are: (1) U-235 - 5 kg, contained in uranium or plutonium in various enrichments in any chemical or physical form (except UF6); (2) Pu (principally Pu-239) - 2.0 kg in any chemical or physical form. Up to 2.0 kg Pu in irradiated fuel is to be used in the Hot Laboratory with less than 1.0 kg Pu in process; and (3) Pu (principally Pu-239) - 1.0 kg in sealed sources as Pu-Be sources.

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Wynveen, R.A., W.H. Smith, C.M. Sholeen, A.L. Justus, and K.F. Flynn, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL

Radiological Survey Support Activities for the Decommissioning of the Ames Laboratory Research Reactor Facility, Ames, Iowa

ANL-OHS/HP-84-106; 78 pp. (1984, September)

A series of radiological measurements and tests were conducted at the Ames Laboratory Research Reactor located in Ames, Iowa. These measurements and tests were conducted during 1980 and 1981 while the reactor building was being decontaminated and decommissioned for the purpose of returning the building to general use. The results of these evaluations are included in this report. Although the surface contamination within the reactor building could presumably be reduced to negligible levels, the potential for airborne contamination from tritiated water vapor remains. This vapor emanates from contamination within the concrete of the buildings and should be monitored until such time as it is reduced to background levels. (Auth)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM HEALTH, SAFETY, AND BIOMEDICAL STUDIES

40

Dickson, H.W., G.S. Hill, and P.T. Perdue, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

Weldon Spring Dose Calculations

ORNL/TM-6272; 28 pp. (1978, September)

In response to a request by the Oak Ridge Operations (ORO) Office of the U.S. Department of Energy (DOE) for assistance to the U.S. Department of the Army (DA) on the decommissioning of the Weldon Spring Chemical Plant, the Health and Safety Research Division of the Oak Ridge National Laboratory (ORNL) performed limited dose assessment calculations for that site. Based upon radiological measurements for a number of soil samples analyzed by ORNL and from previously acquired radiological data for the Weldon Spring site, source terms were derived to calculate radiation doses for three specific site scenarios. These three hypothetical scenarios are (1) a wildlife refuge for hunting, fishing and general outdoor recreation; (2) a school with 40 hour per week occupancy by students and a custodian; and (3) a truck farm producing fruits, vegetables, meat, and dairy products which may be consumed on site. Radiation doses are reported for each of these scenarios both for measured uranium daughter equilibrium ratios and for assumed secular equilibrium. Doses are lower for the nonequilibrium case. In the event that the WSCP site is contaminated with both uranium and thorium ores in secular equilibrium, the projected dose commitments per unit concentration of the parent radionuclides in the soil and measured concentrations in the water for the maximum individual (farm scenario) could be relatively large as compared to existing standards and guidelines concerning radiation exposure. Whole-body dose commitments could exceed 25 mrem/year and organ dose commitments could exceed 200 mrem/year. Based on analyses of environmental samples from the WSCP site, it appears more likely that the site may be contaminated with low levels of processed uranium. If that is the case, the dose commitments to the maximum individual from a unit concentration of U-238 in soil (assuming daughters in the measured ratios) and measured concentrations of radionuclides in water could be less than 0.5 mrem/year to the total body and 5 mrem/year to any reference organ. To arrive at dose commitments lower than this, one must assume the future uses of the site do not include truck farming but are limited to uses such as a game refuge (the lowest calculated dose commitments) or a school (which produces dose commitments intermediate between the farm and game refuge scenarios). (Auth)(JWF)

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Argonne National Laboratory, Argonne, IL

Environmental Assessment, Decontamination and Decommissioning of Plutonium Fabrication Facility, Building 350, ANL-Illinois

DOE/EA-0082 (Rev.); 21 pp. (1979, September 27)

The proposed action is designed to reduce or minimize the potential environmental impact of the plutonium-contaminated surplus equipment by packaging and shipping it to a DOE-managed retrievable TRU-waste storage site or a licensed commercial site. It is anticipated that the majority of the estimated 15,000 cubic feet of waste will be low-level TRU waste which will be shipped by truck to the Idaho National Engineering Laboratory site (INEL). This 15,000 cubic feet of waste, which is less than 0.005 percent of the amount of TRU waste projected to be stored at INEL through 1990, will be placed in containers that meet the 20-year integrity requirements for retrievable storage. Nonradioactive wastes will be disposed of in the onsite sanitary landfill. Non-TRU radioactive waste (approximately 1000 cubic feet) will go to a commercial site at Richland, Washington. The environmental impacts associated with the transportation of radioactive material within the United States under both normal and accidental conditions have been adequately assessed in NUREG-0170. The amount of waste shipped as a result of this action is less than 0.00001 percent of the amounts covered by NUREG-0170. As a result, there are no significant impacts expected during normal transportation activities, and none expected in the event of a transportation accident. Accidental release of plutonium contamination into the Building 350 Fabrication Area will be detected by Health Physics monitoring and surveillance. There are no liquid effluents involved as the small quantities of aqueous detergents are absorbed on rags and thus converted to solid TRU-wastes. Air, soil, and water samples are collected on the Argonne site and off site for routine analyses and assessments of radioactivity levels. It is anticipated that this project will have neither an adverse nor a beneficial environmental effect.

42
Brooksbank, R.E., Oak Ridge National Laboratory, Oak Ridge, TN

Post-Accident Cleanup of Radioactivity at Three Mile Island

DOE/TIC-11023; 27 pp. (1979)

This report presents the plant schematics, equipment modifications, radioactive water processing procedures, and radioactivity levels at the Three Mile Island-2 reactor. (PTO)

43
Brooksbank, R.E., Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN

Decontamination Experience at the Oak Ridge National Laboratory

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. W1 - W19) (1980, October)

The Oak Ridge National Laboratory decommissioning experiences for the Radiochemical Processing Pilot Plant and the Multicurie Fission Product Pilot Plant are discussed. The lessons learned while decommissioning the Radiochemical Processing Pilot Plant include knowing the chemical analysis before using decontamination reagents and awareness of the downstream effects of the use of decontaminants. In addition, the paper describes the analysis and decontamination experiments conducted by ORNL on a plug cut from TMI Penetration R-401. (ARE)

44
King, R.R., Pacific Northwest Laboratory, Richland, WA

Decontamination Experience at Hanford

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. T1 - T34) (1980, October)

Two projects at Hanford involved plutonium contamination. The first decontamination effort was initiated when a container of plutonium oxide ruptured in the storage facility (the 303-C building). The general approach was to prepare the site for safe repetitive entry, followed by clearing the floor area and then decontamination of the structure. The second project involved the 231-Z building which had been used as a plutonium facility for 30 years. Because the plutonium programs were phasing out, the plan was to decontaminate the facility and restore it to useful service. Glove boxes in the facility had to be removed along with their associated piping, ventilation, duct work, and accessory equipment. The residual plutonium hold-up in each item was measured in preparation for retrievable storage burial. After the glove boxes were removed, the facility was further stripped, surveyed, decontaminated, and restored as a modern materials research laboratory. (ARE)

45

Kratzer, W.K., A.P. Larrick, and C.D. Corbit, UNC Nuclear Industries, Inc., Richland, WA

Decontamination Experience at the Hanford N Reactor

CONF-750539; Decontamination of Nuclear Plants, Ohio State University, Columbus, Ohio, May 7-9, 1975; (6 pp.) (1975, April 15)

This paper outlines background and considerations affecting decontamination decisions and procedures at Hanford's N Reactor as decontamination has moved through successive stages that span several years. Specific contaminant reduction figures are given for the internal piping of the reactor, which has gone through decontamination seven times, as well as for off-reactor hardware, maintenance tools, and related materials. Overall cost estimates for the decontamination of the two cells of N Reactor are provided. (JWF)

46

Parke, J.M., and G.H. Phillips, UNC Nuclear Industries, Inc., Richland, WA

N Reactor Piping Decontamination - 1974

UNI-150 (Addenda 1, 2); 105 pp. (1974)

This paper outlines the procedure for the removal of activation products from the inside surfaces of the N Reactor primary front and rear piping in an effort to significantly reduce existing radiation levels in these areas. It includes prerequisite considerations, equipment preparation, and detailed instructions for each reactor section. Manpower and equipment needs are listed. (JWF)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM DISMANTLEMENT AND DEMOLITION

47

Deichelbohrer, P.R., Rockwell Hanford Operations, Richland, WA

"Hot" Tests of the Small Portable Arc Saw Using an Electromechanical Manipulator

RHO-RE-ST-29-P; 38 pp. (1984, September)

Since 1976, a number of different types of arc saws have been tested for use in size reduction of radioactively contaminated metallic scrap. A hand-held portable arc saw was demonstrated in 1982. Known as the Small Portable Arc Saw (SPARCS), it weighed less than 15 lb and could cut metal sheet up to 1/2 in. thick. From the hand-held SPARCS, a manipulator-handled model was developed for use in decommissioning operations by Pacific Northwest Laboratory (PNL). During cold tests, the SPARCS, which was maneuvered with a mechanical, master-slave manipulator, cut 1-in.-thick stainless steel plate. To further the development and utilization of the arc saw, the Waste Management Program, Applied Technology Strategic Planning End Function at Rockwell Hanford Operations provided for an opportunity to test an arc saw at the size reduction facility of Los Alamos National Laboratory. Specifically, the goal of these tests was to demonstrate that the SPARCS could (1) cut up TRU-contaminated scrap, (2) be operated by means of an EMM, and (3) be operated and maintained in a contaminated environment by means of glove/ports. Test results to date show that the saws ability to cut heavy, hard,and inert metal compares favorably with the performance of the plasma torch, a widely used tool for size reduction. The arc saw offers the further advantages of cutting hollow cross-section forms without special procedures, and of cutting without stand-off spacing. Blade performance problems were the most serious shortcomings encountered. (Auth)(JWF)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM SITE STABILIZATION AND RECLAMATION

48

Barber, R.B., Bechtel National, Inc., Oak Ridge, TN

Evaluation of Alternatives for Stabilizing Low-Level Wastes Located at the Weldon Spring Raffinate Pits

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 73-82) (1985)

Approximately 220,000 cubic yards of low-level raffinate sludge and 260,700 cubic yards of contaminated soil and rubble exist at the Weldon Spring Raffinate Pits and nearby quarry. In addition, an estimated 102,000 cubic yards of contaminated soils are present on nearby vicinity properties. Bechtel National, Inc. has performed an evaluation of alternatives for stabilizing these low-level wastes. The results of the evaluation are presented. Costs, schedules, and occupational health effects are compared for each alternative. Conceptual engineering plans for performing remedial action are discussed, including site preparation, water and sludge treatment, construction of the waste containment system, and maintenance and surveillance requirements. (Auth)(DCM)

49

Elder, R.E., Rockwell Hanford Operations, Richland, WA

Decline of Airborne Plutonium Following Decommissioning of a Liquid Waste Disposal Ditch in Hanford's 200 Area

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 28) (1984, November)

The 216-Z-19 Ditch, a low-level liquid waste disposal site in Hanford's 200 West Area, received multigram quantities of plutonium-239 during its 10-year service history (1971-1981). Since 1977 there has been an ambient air sampler stationed near the head end of the ditch. This station consistently measured elevated levels of plutonium-239/240 (ranging from a concentration of 0.003 to 0.044 pCi/cu m with an average of 0.015 pCi/cu m). Resuspension of the plutonium in the ditch soil was determined to be the source of these elevated levels. Through the use of temporary, site-specific air sample stations near the ditch, it was determined that these levels were limited to the head end of the ditch. Following decommissioning and burial of the ditch, the levels of plutonium in the air declined to less than 1% of their former levels and are now at Hanford background levels (approximately 0.00008 pCi/cu m). (Auth)(JWF)

50

Miller, M.G., Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV

Nevada Test Site Area 25, Radiological Survey and Cleanup Project, 1974-1983: A Revised Final Report

DOE/NV/10327-5 (Rev. 1); 106 pp. (1984, December)

This report describes the radiological survey, decontamination and decommissioning (D&D) of the Nevada Test Site (NTS) Area 25 facilities and land areas incorporated in the Nuclear Rocket Development Station (NRDS). Buildings, facilities and support systems used after 1959 for nuclear reactor and engine testing were surveyed for the presence of radioactive contamination. The radiological survey portion of the project encompassed portable instrument surveys and removable contamination surveys (swipe) for beta plus gamma and alpha radioactive contamination of facilities, equipment and land areas. Soil sampling was also accomplished. The majority of Area 25 facilities and land areas have been returned to unrestricted use. Remaining radiologically contaminated areas are posted with warning signs and barricades.

51

Smith, D.L., EG&G Idaho, Inc., Idaho Falls, ID

Decontamination and Decommissioning of the BORAX-V Leach Pond - Final Report

EGG-2300; 28 pp. (1985, January)

The decontamination and decommissioning (D&D) of the BORAX V leach pond located at the Idaho National Engineering Laboratory (INEL) is described. The leach pond became radioactively contaminated from the periodic discharge of low-level liquid waste during operation of the Boiling Water Reactor Experiments (BORAX) from 1954 to 1964. The principal man-made subsurface radioisotopes at the BORAX-V leach pond are Cs-137, Co-60, and Sr-90. This report describes work performed to accomplish the D&D objectives of stabilizing the leach pond and preventing the spread of contamination. D&D of the BORAX-V leach pond consisted of backfilling the pond with "clean" soil, grading and seeding the area, and erecting a permanent marker to identify very low-level subsurface contamination. D&D operations of the BORAX-V leach pond began in July, 1984 and were completed by the end of August, 1984. The total project cost, including labor and material, was $20K. No radioactive waste was generated, and no measurable radiation exposure to workers occurred. (Auth)(DCM)

52

U.S. Department of Energy, Washington, DC

Cleanup Completed at "Project Gnome" Site

DOE Information Weekly Announcements 3(42):3 (1979, October 16)

Cleanup activities at the former U.S. Atomic Energy Commission's (AEC) "Project Gnome" nuclear test site near Carlsbad, New Mexico, have been completed. The cleanup enables the U.S. Department of Energy (DOE) to release the 680-acre site to the custody of the U.S. Department of Interior's Bureau of Land Management. There will be a restriction on drilling or mining near the contaminated cavity zone. Project Gnome was a 3.1 kiloton underground nuclear detonation in a salt formation approximately 31 miles southeast of Carlsbad. It was part of the AEC's program to develop peaceful uses for nuclear explosives. The detonation took place in December 1961. Beginning in mid-May, approximately 23,000 cu yd of contaminated surface salt and soil were crushed, slurried and pumped into the Gnome cavity about 1200 feet underground. Approximately 6,000 cu yd of uncontaminated salt were buried in a deep trench near ground zero. Calculations show that the remaining radioactivity in the soil will increase the normal radiation background level at the site by less than 2 uR/hr. Normal background radiation in the Carlsbad area is approximately 6 to 7 uR/hr. (Auth)(PTO)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM WASTE DISPOSAL

53
Gans, G.M., Jr., and N.H. Lach, Burns and Roe Industrial Services Corporation, Paramus, NJ

Radwaste Concerns During Nuclear Plant Decommissioning

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 495-500) (1982)

The expected issue in 1983 of new Nuclear Regulatory Commission rulemakings on decommissioning will require licensees to give increased attention to planning the ultimate disposal of nuclear facilities. The radwaste management aspects of a nuclear plant decommissioning effort are presented. Matters discussed include waste types and quantities, disposal approaches and some ideas for reduction in waste quantities. Planning for the decommissioning of the Shippingport Atomic Power Station in Western Pennsylvania is the authors' principal point of reference.

54
Merry-Libby, P., Argonne National Laboratory, Argonne, IL

Assessment of Alternatives for Long-Term Management of Uranium Ore Residues and Contaminated Soils Located at DOE's Niagara Falls Storage Site

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 14) (1984, November 5)

About 11,000 cu m of uranium ore residues and 180,000 cu m of wastes (mostly slightly contaminated soils) are consolidated within a diked containment area at the Niagara Falls Storage Site (NFSS) located about 30 km north of Buffalo, NY. The residues account for less than 6% of the total volume of contaminated materials but almost 99% of the radioactivity. The average Ra-226 concentration in the residues is 67,000 pCi/g. Several alternatives for long term management of the wastes and residues are being considered, including: improvement of the containment at NFSS, modification of the form of the residues management of the residues separately from the wastes, management of the wastes and residues at another humid site (Oak Ridge, TN) or arid site (Hanford, WA), and dispersal of the wastes in the ocean. Potential radiological risks associated with long-term management of the wastes and residues are expected to be smaller than the non-radiological risks of occupational and transportation-related injuries and deaths. Dispersal of the slightly contaminated wastes in the ocean is not expected to result in any significant impacts on the ocean environment or pose any significant radiological risk to humans. It will be necessary to take perpetual care of the near-surface burial sites because the residues and wastes will remain hazardous for thousands of years. If controls cease, the radioactive materials will eventually be dispersed in the environment. Predicted loss of the earthen covers over the buried materials ranges from several hundred to more than two million years, depending primarily on the use of the land surface. Groundwater will eventually be contaminated in all alternatives; however, the groundwater pathway is relatively insignificant with respect to radiological risks to the general population. A person intruding into the residues would incur an extremely high radiation dose.

55

DOE Will Clean Up Weldon Spring, Missouri

Radwaste News 5(4):28-29 (1984)

The Weldon Spring Raffinate Pits site is located near Weldon Spring in St. Charles County. The Quarry site is four miles south of the Raffinate Pits site. The U.S. Department of Energy (DOE) has made a commitment to improve the conditions at the two sites. The Raffinate Pits were constructed with the ho of making them a low-level radioactive disposal site. They have about 90, 000 cubic yards of radioactive waste resulting from the operation of the Weldon Spring Chemical Plant. The waste consists of uranium, radium, and contaminated metal scraps. The Quarry site was also intended as a radioactive waste disposal site. Most of the waste at that location came from the Mallinckrodt Chemical Works which converted uranium oxide to uranium fluoride. DOE is considering several options, from doing nothing to moving the entire amount of contaminated soil to another location. (ARE)

56
Stull, E.A., and P. Merry-Libby, Argonne National Laboratory, Argonne, IL

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM WASTE DISPOSAL

Ocean Disposal Option for Bulk Wastes Containing Naturally Occurring Radionuclides: An Assessment Case History

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 569-577) (1985, February 6)

There are 180,000 cu m of slightly contaminated radioactive wastes (36 pCi/g radium-226) currently stored at the U.S. Department of Energy's Niagara Falls Storage Site (NFSS), near Lewiston, New York. These wastes resulted from the cleanup of soils that were contaminated above the guidelines for unrestricted use of property. An alternative to long-term management of these wastes on land is dispersal in the ocean. A scenario for ocean disposal is presented for excavation, transport, and emplacement of these wastes in an ocean disposal site. The potential fate of the wastes and impacts on the ocean environment are analyzed, and uncertainties in the development of two worst-case scenarios for dispersion and pathway analyses are discussed. Based on analysis of a worst-case pathway back to man, the incremental dose from ingesting fish containing naturally occurring radionuclides from ocean disposal of the NFSS wastes is insignificant. Ocean disposal of this type of waste appears to be a technically promising alternative to the long-term maintenance costs and eventual loss of containment associated with management in a near-surface land burial facility.

57

U.S. Department of Energy, Washington, DC

Long-Term Management of the Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site, Draft Environmental Impact Statement

DOE/EIS-0109D; 335 pp. (1984, August)

The statement assesses and compares several alternatives for long-term management of the existing radioactive wastes and residues at the Niagara Falls Storage Site (NFSS), Lewiston, New York. The alternatives include: (1) no action (continued interim storage at NFSS within a diked and capped containment area), (2) long-term management at NFSS (improved containment, with or without modified form of the residues), (3) long-term management at other DOE sites (Hanford, Washington, or Oak Ridge, Tennessee), and (4) offsite management of the residues at Hanford or Oak Ridge and either leaving the wastes at NFSS or removing them for disposal in the ocean. In addition to alternatives analyzed in depth, several options are also considered, including other modifications of residue form, modification of the basic conceptual designs, other containment design options, transportation routes, and transportation modes. The radiological health effects (primarily increased risk of cancer) associated with long-term management of the wastes and residues are expected to be smaller than the nonradiological risks of occupational and transportation-related injuries and deaths. During the action period, the risk is highest for workers if all wastes and residues are moved to Hanford. The risk is highest for the general public if the residues are moved to Hanford and the wastes are moved to the ocean. Dispersal of the slightly contaminated wastes in the ocean is not expected to result in any significant impacts on the ocean environment or pose any significant radiological risk to humans. For all alternatives, if controls ceased, there would be eventual dispersion of the radioactive materials to the environment. If it is assumed that all controls cease, predicted time for loss of covers over the buried materials ranges from several hundred years to more than two million years, depending on the use of the land surface.

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM REMEDIAL ACTION EXPERIENCE

58

Argonne National Laboratory, Argonne, IL

Phase 2 Decontamination and Decommissioning of the New Brunswick Laboratory - New Jersey Site: Interim Report

ANL-OHS/HP-84-110; 305 pp. (1984, November)

The New Brunswick Laboratory-New Jersey Site (NBL-NJ) was used as a general nuclear chemistry laboratory from 1948 to 1977 by the U.S. Department of Energy (DOE) and its predecessors for analytical and standards and assay work relating to nuclear and non-nuclear materials utilized by both the reactor and weapons programs. It consisted of the main building, a Plutonium Laboratory Complex, a Hot Cell, and nine other ancillary structures totaling about 4100 sq m (44, 000 sq ft) of floor area. During the 29 years of operation, NBL-NJ provided a variety of services which utilized nuclear materials such as thorium and uranium ores, high-purity plutonium and americium and uranium enriched in U-233 and U-235. Throughout this period there were periodic contamination incidents, and liquid waste containing various radioactive nuclides was discharged into the sanitary sewer system as permitted by the then applicable AEC concentration guides. In 1960, about 500 cu m (18,000 cu ft) of soil contaminated with Belgian Congo pitchblende was moved from the nearby Middlesex, New Jersey town dump, mixed with clean soil and used to fill (total volume about 3100 cu m) an unused rail siding at the NBL-NJ site. In 1972, plutonium operations were halted due to potential hazard concerns by the AEC and in 1977, all of the remaining NBL-NJ operations and personnel were relocated to new quarters in Illinois. The New Jersey facility was then declared surplus. Deactivation and preliminary decontamination were performed in 1978 (termed Phase I) with the intent of releasing the buildings for unrestricted use. However, follow-up surveys detected contamination in the walls, on the foundations, under floors, and in the sewers. This resulted in the determination that additional and rather extensive cleanup were required. It was decided that each structure would be dismantled, the sewers would be removed, and any soil found to have been contaminated by leaking drains would be dug up (termed Phase II). In addition the previously buried pitchblende contaminated soil would require removal (termed Phase III) before the site could be released unconditionally. Argonne National Laboratory was later designated as the lead contractor for the decontamination and decommissioning (D&D effort). Full-scale D&D of NBL-NJ was initiated in FY 1981. The objectives were: (1) to find and remove all contaminated materials and soil; (2) to assure that all rubble and salvage satisfied the unrestricted release criteria; (3) to minimize the volume of radioactive waste sent offsite for burial; (4) to perform the work with minimum risk to persons involved and to the public; (5) to satisfy all regulatory requirements; and (6) to conduct the project in a cost-effective manner. During the period of March through September 1981 (Phase IIA), all of the above-ground structures were dismantled and radioactive components were segregated, packaged for transport, and sent to the Nevada Test Site for burial. Non-radioactive material was taken to a local landfill or salvaged for reuse. Funding constraints in FY 1982 prevented D&D from continuing so the site entered the maintenance and surveillance mode and remained in that state until mid-1983. D&D resumed in June 1983 (Phase IIB), and consisted of removing the remaining building remnants and sewer lines, back-filling all excavations, grading that portion of the land which was disturbed by the operations, planting ground cover, and performing the necessary actions to certify that all radioactivity had been removed from the area occupied by the buildings and sewers. Overall, Phase II of the project cost about $2.8 million, required some 16 man-years of effort, and generated 330 cu m (11,700 cu ft) of radioactive waste and 5400 cu m (190,000 cu ft) of rubble. Since funding has not yet been authorized for Phase III, the project was returned to the maintenance and surveillance mode in FY 1985. (Auth)(JWF)

59

Bjeldanes, M.N., Northern States Power Company, Minneapolis, MN

Pathfinder

Nuclear News 13(6):56-58 (1979, June)

The Pathfinder reactor was a direct-cycle, boiling water system with an integral nuclear superheater which was forced to shut down in September 1967. Based on several factors, a decision was made to convert the plant to a fossil-fueled system. This article describes the steps that were taken to make this conversion. (ARE)

60

Browder, J.H., and E.L. Wills, EG&G Idaho, Inc., Idaho Falls, ID

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM REMEDIAL ACTION EXPERIENCE

Decommissioning of the MTR-605 Process Water Building at the Idaho National Engineering Laboratory - Final Report

EGG-2361; 60 pp. (1985, January)

Decontamination and decommissioning (D&D) of the unused radioactively contaminated portions of the MTR-605 building at the Test Reactor Area of the Idaho National Engineering Laboratory has been completed. The building is a two-story concrete structure that was used to house piping systems to channel and control coolant water flow for the Materials Testing Reactor (MTR). The MTR was operated from 1952 until 1970 and then deactivated. D&D project objectives were to reduce potential environmental and radioactive contamination hazards to levels as low as reasonably achievable. Primary tasks of the D&D project were: (1) to remove contaminated piping (about 400 linear feet of 36- and 30-in.-diameter stainless steel pipe) and valves from the primary coolant pipe tunnels; (2) to remove a primary coolant pump and piping; and (3) to remove the three 8-ft-diameter by 25-ft-long evaporators from the building second floor. A 100,000-gal sump tank and a 17,000-gal seal tank remain installed for continued use in the TRA radioactive liquid waste cleanup system, a portion of which is housed in the MTR-605 building. Post-D&D radiation levels were greatly reduced after removal of contaminated piping and equipment and performance of decontamination activities. Highest radiation levels after D&D were 150 mR/hr at a single location. D&D operations included plasma arc cutting of 30-in. stainless steel pipe, removal of three 27-ton evaporators from the building second floor, design and construction of a ventilation system to enhance personnel safety, concrete cutting and removal, and cutting and removal of piping and hardware from pipe tunnels and vaults. Cost of the D&D project was $297,000. Waste volumes from this D&D project were 400 linear feet of 36-, 30-, and 8-in.-diameter stainless steel pipe for melting, about 1540 cubic feet of miscellaneous piping and hardware, and 4115 cubic feet of oversize hardware. Total personnel radiation exposure for the MTR-605 D&D project was 4.5 man-rem. Available floor area in the MTR-605 building has been increased by about 5600 square feet. Experience gained during the D&D project demonstrated that plasma arc cutting can be a safe as well as an exceptionally fast method for pipe and metal segmenting in high radiation areas. (Auth)(DCM)

61

Iriarte, M., and J. Hernandez-Fragoso, Puerto Rico Water Resources Authority, San Juan, PR

BONUS

Nuclear News 13(6):51-55 (1970, June)

The Boiling Nuclear Superheater (BONUS) Power Station was a joint project between the U.S. Atomic Energy Commission and the Puerto Rico Water Resources Authority. On June 28, 1968, reactor operations were terminated. The article presents the decommissioning plan, a description of the decommissioning work, the status of the work as of October 1968, the entombment design, and the safety considerations. (ARE)

62

Johnson, R.P., and D.L. Speed, Rockwell International, Rocketdyne Division, Canoga Park, CA

Interim Storage Facility Decommissioning - Final Report

ESG-DOE-13507; 34 pp. (1985, March 15)

Decontamination and decommissioning of the Interim Storage Facility (DOE Facility 654), located approximately 35 miles northwest of downtown Los Angeles at the Santa Susana Field Laboratory, were completed. Activities included performing a detailed radiation survey of the facility, removing surface and embedded contamination, excavating and removing the fuel storage cells, restoring the site to natural conditions, and shipping waste to Hanford, Washington, for burial. The project was accomplished on schedule and 30% under budget with no measurable exposure to decommissioning personnel. (Auth)(DCM)

63

Kline, W.H., H.J. Moe, and T.J. Lahey, Argonne National Laboratory, Argonne, IL

Decontamination and Decommissioning of the Argonne National Laboratory Building 350 Plutonium Fabrication Facility

ANL-85-37; 146 pp. (1985, February)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM REMEDIAL ACTION EXPERIENCE

In 1973, Argonne National Laboratory began consolidating and upgrading its plutonium-handling operations with the result that the research fuel-fabrication facility located in Building 350 was shut down and declared surplus. Sixteen of the twenty-three gloveboxes which comprised the system were disassembled and relocated for reuse or placed into controlled storage during 1974 but, due to funding constraints, full-scale decommissioning did not start until 1978. Since that time the fourteen remaining contaminated gloveboxes, including all internal and external equipment as well as the associated ventilation systems, have been assayed for radioactive content, dismantled, size reduced to fit acceptable packaging and sent to a U.S. Department of Energy (DOE) transuranic retrievable-storage site or to a DOE low-level nuclear waste burial ground. The project which was completed in 1983, required 5 years to accomplish, 32 man-years of effort, produced approximately 540 cu m (19,000 cu ft) of radioactive waste of which 60% was TRU, and cost $2.4 million. (Auth)

64
Moser, C.L., Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID

Decontamination and Decommissioning of CPP-603 BIF Filter Room: Final Report

WINCO-1028; 33 pp. (1984, December)

This report describes the decontamination and decommissioning (D and D) of the Idaho Chemical Processing Plant (ICPP) BIF filter room. The ICPP is located at the Idaho National Engineering Laboratory (INEL). The BIF filter room is adjacent to the middle fuel storage basin of the CPP-603 building. The room became radioactively contaminated during its use as a filtering station for the fuel storage basins water supply. This report describes work performed to accomplish D&D objectives of reducing radiation and contamination problems.

65
Rasmussen, O., Rockwell Hanford Operations, Richland, WA

Closeout Report for the Decontamination and Decommissioning of the 203-S, 204-S, 205-S Facilities

RHO-RE-SR-37-P; 49 pp. (1984, September)

The obsolete 203-S, 204-S, 205-S uranium nitrate hexahydrate purification and storage facility and the radioactive waste tank car unloading equipment in the 200 West Area of the U.S. Department of Energy Hanford Site were decontaminated and decommissioned. Above ground facilities were dismantled and the area was backfilled with a minimum of 2 feet of clean fill over remaining underground concrete structures and piping. Fencing was removed and the site was released as a clean area with underground contamination. (Auth)

66
Schoonen, D.H., Idaho National Engineering Laboratory, Idaho Falls, ID

Reactor Vessel Decommissioning Project Final Report

EGG-2298; 43 pp. (1984, September)

This report describes a reactor vessel decommissioning project; it documents and explains the project objectives, scope, performance results, and sodium removal process. This project was successfully completed in FY-1983 within budget and without significant problems or adverse impact on the environment. Waste generated by the operation included the reactor vessel; drained sodium; and liquid, solid, and gaseous wastes which were significant less than project estimates. Personnel radiation exposures were minimized, such that the project total was one-half the predicted exposure level. Except for the sodium removed, the material remaining in the reactor vessel is essentially the same as when the vessel arrived for processing. (Auth)

67
Smith, D.L., and J.G. Scott, EG&G Idaho, Inc., Idaho Falls, ID

Decontamination and Decommissioning of CPP-601 Process Cells A, B, C, D, and L - Final Report

EGG-2304; 89 pp. (1984, September)

This report describes the decontamination and decommissioning (D&D) of the Idaho Chemical Processing Plant (ICPP) process cells A, B, C, D, and L. The ICPP is located at the Idaho National Engineering Laboratory

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM REMEDIAL ACTION EXPERIENCE

(INEL). These five process cells became radioactively contaminated during nuclear fuel processing in the 1950s and 60s. The report describes the work performed to accomplish the D&D objectives of reducing radiation and contamination problems, and making the cells available for possible future installation of new systems. The contaminated equipment inside each cell was removed as well as the out-of-cell equipment associated with each cell. The interior of each cell was then decontaminated.

68

Suckel, R.A., EG&G Idaho, Inc., Idaho Falls, ID

Decontamination and Decommissioning of the SPERT-I Seepage Pit at the Idaho National Engineering Laboratory - Final Report

EGG-2291; 23 pp. (1984, November)

The scope of the D&D project involved: (a) removing the underground waste line, (b) excavating to a depth of 2.5 ft of contaminated soil from the seepage pit, (c) backfilling the seepage pit, (d) seeding the area with experimental gases, and (e) emplacing a permanent marker indicating subsurface residual radioactive contamination. The D&D operations reduced surface activity from a maximum reading of 196 counts per minute (cpm) to a maximum reading of 76 cpm with no adverse effects on the environment. In addition, backfilling the seepage pit stablized the area to prevent contamination spread through soil surface erosion. D&D operations began in August of FY-1984 and were completed in September 1984. The total cost of the D&D operations was approximately $67,000. (Auth)

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Wheelock, C.W., and R.A. Hewson, Rockwell International, Energy Systems Group, Canoga Park, CA

Retirement of the Piqua Nuclear Power Facility

CONF-691009; Reactor Operating Experience, Proceedings of an American Nuclear Society Conference, San Juan, Puerto Rico, October 1-3, 1969; (pp. 55-56); Transactions of the American Nuclear Society 12(Suppl.):55-56 (1969)

Some of the general conclusions concerning nuclear reactor retirement follow: (1) After removal of fuel and highly radioactive removable components, and the completion of decontamination and protective construction, a reactor plant can be utilized for other purposes without significant hazard. (2) The process of conversion from AEC-DRL operating authorization through dismantlement authorization, to a relatively unrestricted facility authorization, was accomplished within a period of about one year for less than one million dollars. (3) Other plants that have stainless-steel core structures and are exposed to a higher neutron fluence might expect Co-60 concentrations in the order of 100 times those at Piqua, which would increase the time for decay to unrestricted levels by about 35 years. Nickel-63 may constitute a longer-lasting problem; however, further study of the hazards of this isotope to man may show that it would not be more limiting than Co-60. (Auth)

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM GENERAL STUDIES

70
Adams, J.A., J.C. Chattin, P.W. Griffin, and M.C. Hughes, UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Assessment of Decommissioning Alternatives for the Shut-Down Hanford 100 Area Reactors - A Hanford Production Reactor Decommissioning Study

UNI-2619; 96 pp. (1984, May 15)

Of the nine Hanford production reactors, eight have been deactivated since 1971 and are currently being maintained in a safe storage condition. A cost-effective alternative for the ultimate decommissioning of these facilities must be implemented. Abandonment of the facilities is not a feasible alternative because they are deteriorating and could eventually expose radioactive materials to the environment and to human food and water pathways. Three feasible decommissioning alternatives for the shut-down of Hanford 100 Area reactors and associated fuel storage basins have been identified and assessed. Those alternatives are identified, along with summary cost, occupational exposure, and schedule data.

71
Coffman, F.E., U.S. Department of Energy, Washington, DC

Waste Management Policy and Its Implementation in the United States of America

IAEA-CN-43/192; STI/PUB-649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 1, 404 pp.; (pp. 59-68) (1984)

Following the passage of the Nuclear Waste Policy Act of 1982, on January 7, 1983, the U.S. Department of Energy's Commercial Nuclear Waste Program has been restructured to facilitate compliance with that act. The responsibility for carrying out the functions of the Secretary of the DOE under the act have been assigned to the project director of the newly created Nuclear Waste Policy Act project office. That office will be operational until the mandated Office of Civilian Waste Management is activated. Those commercial waste management programs - Remedial Action Program, West Valley Demonstration Project, Commercial Low-Level Waste and Waste Treatment, and the Three Mile Island Program - which do not fall within the purview of the act are the responsibility of the Office of Terminal Waste Disposal and Remedial Action. These programs are described in the paper, which references those laws from which the federal policy evolves.

72
Coobs, J.H., Oak Ridge National Laboratory, Oak Ridge, TN

Surplus Facilities Management Program

ORNL/NFW-82/37; ORNL Nuclear Waste Programs Annual Progress Report for Period Ending September 30, 1982; (pp. 39-47) (1983, May)

Defense waste activities of surplus facilities are reported. At the Metal Recovery Facility, defective roof hatches were replaced, radionuclide content of the canal was monitored, and a complete report on radiological characterization of the facility was issued. The stack was cleaned and cleared of debris at the ORNL Graphite Reactor in addition to regenerating demineralizer and routine filter replacements. Decontamination of the manipulator cells in the Curium Facility was completed by using a combination of techniques. Contamination levels in the cells are acceptable for the planned alternate use of the facility. The abandoned transfer lines across the White Oak Creek floodplain and the high-pressure line from the old hydrofracture to the New Hydrofracture Facility were excavated and removed. The high-pressure pipe was salvaged and stored for reuse, and the abandoned pipeline was disposed of as waste.

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Coobs, J.H., Oak Ridge National Laboratory, Oak Ridge, TN

Surplus Facilities Management Program

ORNL/NFW-82/37; ORNL Nuclear Waste Programs Annual Progress Report for Period Ending September 30, 1982; (pp. 303-304) (1983, May)

This is the second of two programs that are concerned with the management of surplus facilities. The facilities in this program are those related to commercial activities, which include the three surplus experimental and test reactors [(MSRE, HRE-2, and the Low Intensity Test Reactor (LITR)] and seven experimental loops at the ORR. The program is an integral part of the Surplus Facilities Management Program, which is a national program administered for DOE by the Richland Operations Office. Very briefly reported here are routine surveillance and maintenance of surplus radioactively contaminated DOE facilities awaiting decommissioning.

74
DeLaney, E.G., and J.R. Mickelson, Sr., U.S. Department of Energy, Division of Remedial Action Projects, Washington, DC; UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

United States Department of Energy Decommissioning Experience: Selected Projects

UNI-SA-137; CONF-8410213; NEA Workshop on Storage with Surveillance Versus Immediate Decommissioning for Nuclear Reactor Components and Buildings, Paris, France, October 22, 1984; (35 pp.) (1984, October 22)

The Surplus Facilities Management Program has implemented three distinct decommissioning options: Safe Storage; Entombment; and Dismantlement. Some facilities have undergone a combination of these options during their decommissioning. Examples are given of each of the three options.

75
Dismantling of the First American Nuclear Power Station of Significant Size

Electro-Revue 76(1):10 (1984, January 4)

The project assigned by the U.S. Department of Energy to General Electric for the complete dismantling of the 60 MW pioneer Shippingport nuclear power station which was operational from 1957 to 1983 is described. The company sees one of its main aims as the gathering of practical experience for future decommissioning of worn-out nuclear power stations. New handling techniques for radioactive material are to be tried, and parts of the light-water reactor broken up under water. The work is expected to take four and a half years.

76
Hindman, S.

Dismantling the Myths About Nuclear Decommissioning

Public Citizen/Environmental Action Report; 68 pp. (1985, April)

This report examines the general nature of past experiences with reactor decommissioning, dismantling, and site restoration, including both stated and hidden cost estimates. It surveys existing regulatory policies at the federal and state levels, and recommends twelve additional areas of federal regulation and two at the state level. Included is a listing of all currently licensed nuclear power facilities. (JWF)

77
Miller, C.E., Jr., U.S. Department of Energy, Richland Operations Office, Richland, WA

Shippingport Station Decommissioning Project Engineering Results

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 39-41); Transactions of the American Nuclear Society 45:39-41 (1983)

The purpose of the Shippingport Station Decommissioning project is to place the Shippingport Atomic Power Station in a long-term radiologically safe condition following defueling of the reactor. In addition, the decommissioning will be performed in such a manner as to demonstrate application of decommissioning procedures to a large nuclear power plant and to provide useful data for future decommissioning projects.

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Olson, S.

Nuclear Undertakers

Science 5(7):50-59 (1984, September)

The Shippingport Atomic Power Station, the first commercial nuclear central electric-generating station in the

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM GENERAL STUDIES

U.S., will soon be taken apart and buried in a process known as decommissioning. Beginning in the spring of 1985, and expected to last four years, the process will be closely watched by both the nuclear industry and its critics. A small crew has just finished removing the last fuel assemblies from the reactor's nuclear core; however, the pressure-vessel walls remain intensely radioactive. The author outlines the radiation protective measures that will be used as the workers cut and saw to disassemble the 21 miles of piping inside the plant, e.g. building plastic enclosures around certain work areas to trap radioactive dust and working behind shielding as positioned saws do the cutting. Also, any radioactive concrete in the plant will be removed, again using the best radiation-protective measures. Once the decommissioning team works its way into the heart of the reactor, the pressure vessel - a steel cylinder 35 ft high and 10 ft across with walls 8 inches thick - plans call for erecting a tower above and pouring concrete into the cavity around the vessel. The 770-ton steel and concrete package will then be hoisted in one piece, placed on a heavy-duty transporter and hauled to a barge on the Ohio River, eventually following a water route to the Hanford, Washington energy reservation; there it will join some other 120 truckloads of other radioactive wastes from its plant for burial. Even if this is successfully accomplished as planned and at the $80 million estimate, critics point out that decommissioning the much larger plants will be much more complex and costly - that Shippingport is far from an analogous situation.

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Owen, P.T., D.C. Michelson, and N.P. Knox, Oak Ridge National Laboratory, Information Resources Organization, Oak Ridge, TN

Bibliographic Citations Pertinent to the Weldon Spring Site, St. Charles County, Missouri

ORNL/TM-9730; 65 pp. (1985, July)

This report is a compilation of 166 bibliographic references pertinent to the Weldon Spring Site (WSS), St. Charles County, Missouri. The WSS is a surplus U.S. Government facility which consists of the Weldon Spring Chemical Plant; two separate low-level radioactive waste storage properties, designated the "raffinate pits" and "quarry"; and a number of potentially contaminated vicinity properties. The facility was used by the U.S. Atomic Energy Commission from 1957 to 1966 to refine uranium. After several years the U.S. Department of the Army acquired responsibility for the Weldon Spring Chemical Plant, performed some limited radiological decontamination, and then cancelled plans to reactivate the chemical processing facility. Contamination of the facility and adjacent lands resulted from operation of the refining facility and the storage, transport, and disposal of process wastes on the property, as well as subsequent decontamination activities. All identified references to published technical documents that relate to the WSS were included in this report. In some cases citations from the reference section of existing documents were included in this report with no hardcopy to substantiate the existence of the document referenced. (PTO)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, October-December 1984 - Civilian Program

SFMP-85-1 (Civilian); 112 pp. (1985)

Highlights of the progress of the civilian program as reported by the area offices are: (1) Albuquerque - Mound Advanced Nuclear Systems and Projects Division Areas Decommissioning - Structural decontamination was completed in the Plutonium Processing 157 and 158 areas. Final radiological surveys and sealing of the walls and ceilings were completed in November. Preparations continued on the removal of the above ground portion of Building 41; (2) Chicago - Argonne National Laboratory - East Surplus Facilities Decommissioning - Decontamination of Building 38 (Fan House No. 2) was completed in November. A total of 1,500 cubic feet of soil was packaged and disposed from around the building. Decontamination of Building 17 (Hot Machine Shop) continued. Except for the concrete floors, all radiological surveying and decontamination is complete; (3) Idaho - The SPERT-I Seepage Pit final report was published and distributed in November. Monticello Site Remedial Action - The final site analysis report was forwarded to SFMPO and DOE-HQ on December 14. Remedial action constructions have been completed on seven designated Monticello Vicinity Properties, and signed owner acceptance forms have been received for all seven. Nineteen of twenty scheduled radiologic and engineering assessment (REA) field surveys were completed. Engineering design has been

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM GENERAL STUDIES

completed on the fifteen originally designated properties and on Properties 97, 99 and 150. An REA was completed on Property 134; (4) Oak Ridge - Weldon Spring Remedial Action - The clearing and the grid survey of the quarry were finished. Drilling in the quarry for radiological sampling started in mid-November. The Preliminary Draft Environmental Impact Statement (EIS) for the Weldon Spring Quarry and Raffinate Pits Sites is in preparation. The Addendum to the Engineering Evaluation of Alternatives was revised by DOE-ORO in November. Niagara Falls Storage Site Remedial Action - Transfer of the K-65 residues from Building 434 to Building 411 continued to be the principal activity at the site; (5) Richland - Shippingport Station Decommissioning Project Office (SSDPO) met with General Electric and Morrison-Knudsen representatives on site October 4 to discuss the Decommissioning Operations Contractor's (DOC) performance of a Total Project Cost Estimate (TPCE) for the SSDP. The DOC TPCE team was given instructions on how to proceed with the task, interim checkpoints, target completion date, and required deliverables. Detailed planning, engineering, and general preparations for decommissioning operations commenced January 1, 1985. Program Administration - The SFMP FY 1985-1989 Program Plan was completed and issued in final form to program participants in October 1984. The document, in part, addresses planned decommissioning activities at the participating SFMP sites for the next five-year period. The 1984 SFMP Budget and Program Planning Conference was held October 30, 31, and November 1, 1984 in Knoxville, Tennessee; (6) San Francisco - Radioactive Materials Disposal Facility/Interim Storage Facility (RMDF/ISF) Decommissioning - ISF soil and asphalt decontamination was completed in October. Disposal of Na/NaK/LiH Waste - Disposal of 5,173 pounds of sodium was accomplished, bringing the total to date of 18,821 pounds disposed out of the total inventory of 27, 500 pounds. NMDF (Building 055) Decommissioning - The tunnel section, glovebox removal task for the Nuclear Materials Development Facility was completed in November. A budget summary of the Civilian Program is presented, and individual progress sheets for each task/project are included. (Auth)(DCM)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, October-December 1984 - Defense Program

SFMP-85-1 (Defense); 76 pp. (1985)

Highlights of the progress reported by the area offices for the defense program include: (1) Albuquerque - Special Metallurgical Building Decommissioning - Removal of Storage Room 77 was completed in October; the enclosure used during the decommissioning of the Repackaging and Redrumming was removed in November; (2) Chicago - New Brunswick Laboratory Site Surveillance - The interim report on Phase II decommissioning work at NBL was completed and issued in December; (3) Idaho - INEL Surplus Facilities Surveillance - The Measurement and Instrumentation section and the Dose and Concentration Guidelines section of the release criteria document were completed and transmitted to DOE-ID for review. Idaho Chemical Processing Plant Surplus Facilities Decommissioning - The D&D final report for CPP-603 BIF Filter Room was published in December. Initial Engine Test Facility Decommissioning - A draft of the IET Facility Decision Analysis was transmitted to DOE-ID for review in December. Analysis results indicated that as much of the facility as possible be decontaminated and returned to possible further use; (4) Oak Ridge - Metal Recovery Facility Decommissioning - The building preparation phase for MRF decommissioning continued from FY 1984 and was completed in December. The make-up area heating and cooling unit, the cell ventilation system, and the electrical system were installed, tested and are available for use. Completion of this milestone marks the end of the first phase of the MRF decommissioning effort. Fission Products Development Laboratory Cell Decommissioning - Initial decontamination of Process Cell 2 was completed in November, in preparation for subsequent equipment removal activities, which were completed in December. Decontamination of Manipulator Cell 18 was initiated in October and continued through December. Equipment removal efforts were initiated in November using a small manipulator-controlled plasma arc cutting torch system. An estimated 50% reduction in cutting time was realized with this system; (5) Richland - 100-F Area Facilities Decommissioning - The Conceptual Design Report on In Situ Decommissioning of the Eight Shutdown 105 Buildings in the 100 areas was finalized in December, and submitted to DOE-RL for review. The report provides technical and management approaches for decommissioning the surplus reactor buildings in the 100 Areas, and is a major supporting document for the NEPA process. 100-D Area Facilities Decommissioning - Activities continued on the 105-DR Fuel Storage Basin. Water/sludge removal in the basin was completed in October. Demobilization and transfer of the equipment was completed in November. Asbestos removal in the 105-D

Reactor Building began in October and was completed in December. Program Administration - The SFMP FY 1985-1989 Program Plan was completed and issued in final form to program participants in October. The 1984 SFMP Budget and Program Planning Conference was held October 30, 31, and November 1, 1984 in Knoxville, Tennessee. The first issue of the SFMP Technical Information Exchange Bulletin was distributed to program participants at the Planning Conference. A budget summary for the reporting period and individual reports for each task/project are included in this document. (Auth) (DCM)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, January-March 1985 - Civilian Program

SFMP-85-2 (Civilian); 113 pp. (1985, January-March)

Highlights from the progress reported by the area offices for defense program work include: (1) Albuquerque - Mound ANSPD Areas Decommissioning - Structure decontamination in PP-124 and PP-126 was completed in January as scheduled. WTS line removal and contaminated soil removal remain on hold because of inclement weather. Preparation for Building 41 demolition resumed in March. Glovebox removal in R-120 was completed in March, three weeks ahead of schedule; (2) Chicago - ANL-East Surplus Facilities Decommissioning - Building 17 D&D work is above five months ahead of schedule. Decommissioning activities were initiated in Building 22 in February and continued throughout March; (3) Idaho - (a) SPERT and BORAX Ancillaries Remedial Action - The BORAX-V Pond D&D Report was published in January as scheduled; (b) Monticello Site Remedial Action - Work continued on the Environmental Assessment. The appendix was outlined and conceptual engineering design work was completed. The Peripheral Properties report has reviewed and the final version is being prepared; (c) Monticello Vicinity Properties - The draft Radiologic and Engineering Assessments for properties, 69, 92, 93, 94, 97, 99, 138, and 150 have been completed and circulated for review and concurrence. A final format for the completion reports has been established but not approved. Remedial Action Agreements (RAAs) and work statements are being prepared for the first group of properties to be let out for bid: Property numbers 14, 86, 133, 134, 138, and 150. Based on construction experience so far, indications are that the volumes of contaminated materials are higher than originally anticipated and will result in increased costs to the MVP project; (4) Oak Ridge - (a) Center for Energy and Environment Research Facility Decommissioning - DOE OR visited with personnel from the University of Puerto Rico and the Puerto Rico Electric Power Authority (PREPA) on March 1 to discuss the possibility of storing the CEER decommissioning waste at the BONUS facility. Preparation of the Draft Project Plan has been delayed; (b) Weldon Spring Site Remedial Action - Radiological characterization drilling in the Quarry was completed in January. The plan for limited DOE/BNI participation in the St. Charles County Well-Field Expansion Study was developed in January. Work continued on preparation of the Addendum to the Engineering Evaluation of Alternatives. The MOU between the DOE and Department of Army concerning transfer of custody of the Weldon Spring Chemical Plant (WSCP) to DOE was signed in February. The Weldon Spring Site Remedial Action has been approved for designation as a Major Project within the DOE's Project Management System; (b) Molten Salt Reactor Experiment Facility Decommissioning - The preliminary feasibility study for extended in-place storage of the fuel and flush salts was completed in March as scheduled; (c) Niagara Falls Storage Site Remedial Action - During early January, the focus at the site was on attempting to complete the K-65 residue transfer from Building 434 to Building 411. Water treatment at NFSS continues to be a major challenge. On March 25-26, meetings were held with representatives of the State of New York and the EPA to resolve the DOE/ANL responses to their comments on the DEIS; (5) Richland - (a) Shippingport Station Decommissioning - GE has requested deferral of the planned Cost/Schedule Control System (C/SCS) Application Review for April to later in the fiscal year. SSDPO management concern over the completeness and quality of C/SCS documentation continues. Preparation continued for negotiations between DOE-RL and GE on the DOC definitive contract; (b) Program Administration - The FY 1987 Budget Submittal for the Remedial Action Program was completed and will be transmitted to DOE-HQ on April 3. The analysis of the SFMP long-range plans was transmitted to Headquarters on January 31, one month ahead of schedule. Production of the NEA Decommissioning Questionnaire Compendium was completed in January; (6) San Francisco - (a) RMDF/ISF Decommissioning - The ISF D&D final report was completed in January and issued in March. Radioactive waste shipments from ISF were completed in March, approximately four months behind schedule; (b) Disposal of Na/NaK/LiH Waste - A total of 2,045 pounds of sodium were disposed of during this report period. A plan of action was prepared in February to economically incinerate the cold traps containing sodium; (c) Nuclear Material Development Facility (Building 055) Decommissioning - In January, the radioactive exhaust system piping (low-volume exhaust) for the gloveboxes in the glovebox room was removed, segmented, and packaged for disposal. (PTO)

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UNC Nuclear Industries, Inc., Office of Surplus Facilities Management, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, January-March 1985 - Defense Program

SFMP-85-2 (Defense); 73 pp. (1985, January-March)

Highlights from the progress reported by the area offices for defense program work include: (1) Albuquerque - Special Metallurgical (SM) Building Decommissioning - The SM Building utility relocation was completed as scheduled in February. Preparation for removal of R-149 gloveboxes was completed as scheduled. Removal of R-149 gloveboxes was initiated during March; (2) Chicago - New Brunswick Laboratory Site Surveillance - Analysis of the monitoring-well samples taken in November has been completed; (3) Idaho - INEL Surplus Facilities Surveillance - The annual inspection of surplus contaminated defense facilities was completed, as was the plan to cover the FY 1985 maintenance needs for the facilities. The INEL D&D release criteria was completed and submitted to DOE-ID for review and approval; (b) Materials Testing Reactor Facilities Decommissioning - In January a final report for MTR-605 Process Water Building was completed as scheduled. Publication of the report satisfied a Headquarter-controlled milestone. A D&D plan for the MTR HB-2 Cubicle was completed and published during March; (c) Initial Engine Test Facility Decommissioning - The IET Facility Decision Analysis was completed and published as scheduled. Work was started on the IET Facility D&D plan during February, and a draft of the plan is expected to be complete and ready for review in May; (5) Oak Ridge - (a) Metal Recovery Facility Decommissioning - Equipment removal activities were completed in Cell A, the Makeup Area, and the Cell Galleries as scheduled. In cell A, the remaining off-gas lines were removed and the cell placed in a standby condition in preparation for work in the adjacent Cell B. The Makeup Area is undergoing cleanup and minor decontamination for use in the next phase of cell equipment removal (Cells C-G); (b) Fission Product Development Laboratory Cell Decommissioning - Decommissioning activities for Process Cell 2 were completed ahead of schedule in February. Final procedures development for the Cell 7 valve removal activities was completed in March; (6) Richland - (a) Hanford 200 Areas Surplus Facilities Surveillance - Physical roof repairs at Redox were completed in January. Application of polyurethane over a small portion of the roof was subsequently completed in March to finish the task; (b) 100-F Area Facilities Decommissioning - 100 Area characterization was furthered as the draft copy of the source term document was completed. Internal review is expected to be completed in April. This document identified the types and amounts of radionuclides remaining in the 100 Areas effluent systems, solid waste disposal sites, and ancillary facilities. The final draft of the individual facility decommissioning report for the 115-F Gas Recirculation Building has been completed and issued to DOE-RL for approval of report format; (c) 100-D Area Decommissioning - The Decommissioning Project Readiness Review for the 115-D/DR Gas Recirculation Building is complete and decommissioning activities started in March. Asbestos removal on the interior of the 105-DR Building was completed with the exception of the two small pie runs in the transfer bay. Asbestos removal on the exterior of the building has been initiated; (d) 201-C Strontium Semiworks Decommissioning - Decontamination for the 201-C galleries above the first floor was completed in February. Dismantlement of the 201-C Hot Shop is progressing on schedule. All equipment has been removed from the interior of the shop. The Environmental Assessment for the decontamination and decommissioning of the Strontium Semiworks was issued to DOE-RL in February; (e) 224-B Concentration Facility Decommissioning - Development of a project plan for D&D of the 224-B Concentration Facility continued on schedule. Radiological characterization of the facility was completed in January; (f) Program Administration - The second SFMPO Technical Exchange Bulletin was completed and distributed to Program Participants in February. The FY 1987 Mid-Year Call Letter was issued in late February to SFMP participants. The National Technical Transfer Program Management Action Plan was completed in March. The FY 1987 Budget Submittal for the Defense D&D Program was completed and transmitted to DOE-RL on March 22, 1985 as scheduled. (Auth)(PTO)

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United Nuclear Industries, Inc., Nuclear Operations Division, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, July-September 1984 - Civilian Program

UNC/OSFM-84-1 (Civilian); 107 pp. (1984)

Highlights from the progress reported by the area offices for the Civilian Program include: (1) Albuquerque - Mound ANSPD Areas Decommissioning - The PP-34 glovebox removal phase was completed in July and 1,000 linear feet of WTS line was removed in August. Final structural decontamination of PP 128, 130, and 175-178 was completed on schedule. Construction of Building 41 containment structure was completed in September. Structural decontamination of PP 142E, 158E, 159, 160, 162, 163, and 164 was completed in July. (2) Chicago - ANL-East Surplus Facilities Surveillance - Two facilities no longer require surveillance since they are being decontaminated and/or dismantled. ANL-East Site Planning and Risk Assessment - The Long-Range Site Decommissioning Plan was finalized. ANL-East Facilities Decommissioning - The building was released for demolition after two remaining rotoclone/precipitrons were dismantled. (3) Idaho - INEL Facilities Decommissioning - The SPERT-I Seepage Pit decontamination and decommissioning was completed in August. A draft final report was completed. Monticello Site Remedial Action - Efforts continued on completion of the final Site analysis Report. The first draft of the Project Plan was submitted for internal review. Monticello Vicinity Properties - A preconstruction inspection for bid groups No. 1 and 2 was conducted and construction initiated in September. A cumulative total of fourteen radiological and Engineering Assessments have been completed through the engineering and design phase. (4) Oak Ridge - ORNL site Planning and Risk Assessment - Preliminary cost and schedule estimates have been completed for all facilities currently in the ORNL SFMP inventory. Project priorities have been established and the project cost and schedule integrated into an overall program plan. The final ORNL Long Range Site Decommissioning Plan was issued in September. Weldon Spring Site Remedial Action - A draft Weldon Spring Site Geologic Report was issued. Work continued on the Addendum to the WSS Engineering Evaluation of alternatives. Design engineering was completed and subcontracts for clearing the quarry, repair of the pedestrian bridge and the grid survey of the quarry were awarded. Niagara Falls Storage Site Remedial Action - The Draft Environmental Statement Impact was issued for public review on August 17. Phase I and II of the interim cap are complete and Phase III is 65% complete. Treatment of the water in Building 409 reduced the uranium level by about 75%, but not low enough to meet discharge criteria; (5) Richland - Shippingport Station Decommissioning - the Operational Readiness Review findings concluded that while General Electric was ready to perform its assigned duties, it would require additional time to fully prepare itself to accept unconditional custodial responsibility for the site. Responsibility for the facility and site were turned over from DOE-Naval Reactors and Duquesne Light Company to DOE-RL and GE effective September 6. Program Administration - the FY 1985 Budget Guidance and Call for Program Plan updates to all participating field offices was transmitted on August 22. On August 30, the draft SFMP FY 1985-1989 Program Plan was transmitted to SFMPO. Sections of the draft NEA Decommissioning Study were reviewed. (6) San Francisco - RMDF/ISF Decommissioning - evacuation of the Interim Storage Facility was completed in August; all of the steel tubes were removed without incident. Disposal of Na/NaK/LiH Waste - 1838 pound of sodium were disposed of, leaving 13,852 pounds remaining. NMDF (Building 055) Decommissioning - decontamination of the tunnel sections was completed in mid-July. The work sequence for separating and removing glovebox and tunnel sections has been altered due to a low probability risk that an earthquake could topple the unattended boxes. The gloveboxes and tunnel sections are now being packaged for shipment as they are removed from their respective lines. (Auth)(ARE)

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United Nuclear Industries, Inc., Nuclear Operations Division, Richland, WA

Surplus Facilities Management Program Quarterly Progress Report, July-September 1984 - Defense Program

UNC/OSFM-84-1 (Defense); 107 pp. (1984)

Highlights from the progress reported by the area offices for the Defense Program include: (1) Albuquerque - Special Metallurgical (SM) Building Decommissioning - Decommissioning of the Repackaging and Redrumming Annex was completed in July. (2) Idaho - INEL Site Planning and Risk Assessment - The Long-Range Site Decommissioning Plan was completed in August. Idaho

CHAPTER 1. SURPLUS FACILITIES MANAGEMENT PROGRAM GENERAL STUDIES

Chemical Processing Plant Surplus Facility Decommissioning - Decontamination of ICPP Process cells was completed in August and the D&D project final report for CPP Process Cells A, B, C, D, and L was published in September. The CPP-603 BIF Filter Room D&D operations were also completed in September. Materials Testing Reactor Facilities Decommissioning - Decommissioning of the MTR-605 process water building was completed in September. (2) Oak Ridge - ORNL Site Planning and Risk Assessment - The Long-Range Site Decommissioning Plan for surplus facilities was issued. Metal Recovery Facility Decommissioning - Cleanup efforts in the MRF Canal and the engineering design for the decontamination phase were completed. Onsite work concentrated on the installation of steam lines, the heater unit, and placement of concrete pads for the ventilation unit. Fission Products Development Laboratory Cell Decommissioning - Manipulator Cells 13-15 were decontaminated to a condition that allows limited access for subsequent refurbishment and reuse. (3) Richland - Hanford 100 Areas Site Planning and Risk Assessment - The Long-Range Site Decommissioning Plan was issued in August. Hanford 200 Areas Site Planning and Risk Assessment - The Long-Range Site Decommissioning Plan was issued in July. 201-C Strontium Semiworks Decommissioning - Dismantlement of the 271-C Aqueous Makeup Building was completed. 100-D Area Facilities Decommissioning - Sludge and water removal from the 105-D was completed in September. 100-F Area Facilities Decommissioning - Following DOE approval of the Allowable Residual Contamination Level (ARCL) methodology for determining threshold levels for decommissioning work in the 100 Areas, demolition of the 115-F Gas Recirculation Building was completed in September. 100-H Area Facilities Decommissioning - Demolition of the 117-H Filter Building was completed in September, following DOE approval of the ARCL methodology for determining threshold levels for decommissioning work in the 100 Areas. (Auth)(ARE)

Chapter 2

NUCLEAR FACILITIES DECOMMISSIONING

- Design, Planning, and Regulations
- Environmental Studies and Site Surveys
- Health, Safety, and Biomedical Studies
- Decontamination Studies
- Dismantlement and Demolition
- Site Stabilization and Reclamation
- Waste Disposal
- Remedial Action Experience
- General Studies

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Quality Assurance Program Requirements for Post Reactor Nuclear Fuel Cycle Facilities

ANSI-N-46.2-1978; American Society of Mechanical Engineers, New York, NY (1979)

This standard presents requirements for the establishment and execution of quality assurance programs for the design, procurement, construction, operation and decommissioning of post reactor nuclear fuel cycle facilities. It applies specifically to spent fuel and waste storage installations, fuel reprocessing plants, plutonium processing and plutonium fuel fabrication plants, and other post reactor related facilities. This consolidated standard supersedes: ANSI 46.2-1977, Rev. 0; ANSI-N-46.2.6 (Draft 7, 1977); ANSI-N-46.2.9 (Draft 1, Rev. 2, 1977); ANSI-N-46.2.11-1977; ANSI-N-46.1.12 (Draft 2, Rev. 0, 1976); and ANSI-N-46.2.13-1977.

87

Atomic Industrial Forum, Inc., Washington, DC

An Overview of Decommissioning Nuclear Power Plants

Report; 6 pp. (1983, March)

This overview of nuclear power plant decommissioning has been prepared to provide up-to-date, general information on the subject. Some decommissioning issues have been frequently misunderstood. This is particularly true in the area of costs and availability of funds needed to carry out necessary decommissioning procedures at the end of normal plant service life. In this report, an attempt has been made to place these issues in a proper perspective. Current technology and existing regulations adequately provide for the safe decommissioning of a nuclear power plant within acceptable costs after the nuclear fuel has been removed from the facility. There are several ways to decommission a power reactor and to safely dispose of the residue. Similarly, there are several ways to finance and collect funds for decommissioning. The decision concerning which technical and financial alternatives to choose must be based on the site-specific characteristics and should be determined on a plant-by-plant basis. It is important to consider the utility's preference, the rate setting bodies' desires, the cost to the consumer, and the need for utility and regulatory flexibility in the development of a regulatory policy for decommissioning. (Auth)(PTO)

88

Bohnenkamp, K., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Licensing Procedure of the NS Otto Hahn

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 25-30) (1983, January 26)

With the nuclear ship, Otto Hahn, the utilization of guidelines has been applied for the first time. The office for working protection attended to the licensing procedures as well as to control during normal operation. The progress of shut-down and the man-rem result showed that the licensing, to the extent defined by the rule, was sufficient and practicable. The principle of control in several stages carried out by the orderer, the TUeV, the office for industrial safety, and the PTB has proved adequate.

89

Specification for a Total Quality Assurance Programme for Nuclear Power Plants

BS-5882-1980; 7 pp. (1980)

This standard specifies principles for the establishment and implementation of quality assurance programs during all phases of design, procurement, fabrication, construction, commissioning, operation, maintenance and decommissioning of structures, systems and components of nuclear power plants.

90

Burstall, R.F., G.H. Clarke, and C.D. McElroy, United Kingdom Atomic Energy Authority, Risley Nuclear Power Development Establishment, Risley, Warrington, United Kingdom

Shielding Requirements for the Decommissioning of WAGR

Radiation Shielding, Volume 2; (pp. 1173-1182) (1983)

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A number of shielding studies have been made for the decommissioning of WAGR. Some of the aspects of the work are explained. The activities of the main components of the reactor as functions of time after reactor shut-down and the uncertainties of the activities are considered. The importance of linking calculations to measurements is demonstrated. Shielding requirements are considered for the dismantling of the pressure vessel and associated components. The removal and safe transportation of the steel plates are studied together with the shielding for a waste packaging building.

91
Buta, R.R., and R.E. Palmer, Bechtel Power Corporation, Gaithersburg, MD

Evolution of Decommissioning Costs

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 38-39); Transactions of the American Nuclear Society 45:38-39 (1983)

While most operating nuclear power plants are still in the relative youth of their project service lives, the owners have already made financial plans for the ultimate retirement of the facilities. The costs associated with decommissioning an operating facility, regardless of the number of generating units, are extensive and of current importance to the owner. The impact of the cost estimate is reflected in accounting issues such as depreciation, salvage units, unsegregated reserve versus sinking fund, taxes, and cash flow. Inclusion of the decommissioning costs in current electricity rate structures ensures the intergenerational equity concept. It is in the best interests of the owner and future consumers that the decommissioning costs included in the rate base represent a current and comprehensive estimate, regardless of the decommissioning method selected. A review of representative decommissioning studies and estimates conducted between 1975 and 1982 reveals a growth in estimated costs that exceeds adjustments for inflation.

92
Buta, R.R., and R.E. Palmer, Bechtel Power Corporation, Gaithersburg, MD

Analysis of Decommissioning Cost Estimates for Nuclear Operating Plants

Public Utilities Fortnightly 114(2):47-49 (1984, July 19)

Rate adjustments to accumulate the capital needed to decommission nuclear power plants require complex cost estimates that must be accurate, plant-specific, and defensible. The radioactive nature of the facility makes it more difficult to estimate decommissioning than construction costs. Of the decommissioning methods, safe storage (SAFSTOR) and entombment (ENTOMB) are interim solutions, with dismantlement (DECON) taking place after 30 to 100 years. This analysis shows DECON to be the least expensive over the long term and the most attractive. New technical knowledge and more stringent industry standards call for periodic adjustments of the cost estimates, which now have only a periodic escalation for inflation. This results in understated costs.

93
Cantor, R.A., Oak Ridge National Laboratory, Oak Ridge, TN

Regulatory Trends and Practices Related to Nuclear Reactor Decommissioning

CONF-841136; Proceedings of the Sixth Annual North American Meeting of the International Association of Energy Economists, San Francisco, CA, November 5, 1984; (16 pp.) (1984)

In the next several decades, the electric utility industry will be faced with the retirement of 50,000 MW nuclear capacity. Responsibility for the financial and technical burdens this activity will entail has been delegated to the utilities that are currently operating the reactors. However, the operators will have to perform the tasks of reactor decommissioning within the regulatory environment dictated by federal, state and local regulations. The purpose of this paper is to highlight some of the current and likely trends in regulations and regulatory practices that will significantly affect the costs, technical alternatives, and financing schemes encountered by the electric utilities and their customers.

94
Cantor, R.A., Oak Ridge National Laboratory, Oak Ridge, TN

Nuclear Reactor Decommissioning: An Analysis of the Regulatory Environments

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DOE/OR/21400-T39; 162 pp. (1984, April)

The purpose of this study is to highlight some of the current and likely regulations encountered by electric utilities and their customers that will significantly affect the costs, technical alternatives, and financing schemes for reactor decommissioning. The paper includes a general review of the decommissioning literature, as well as information on specific regulations at the federal, state, and utility levels. Available estimated costs for the decommissioning of individual reactors are also presented. Finally, classification of the specific policies into common trends and practices among the various regulatory bodies is used to examine more general regulatory environments and their potential financial implications.

95

Chapuis, A.M., M. Hulot, W. Jager, and R. Panter, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, France; GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany; United Kingdom Atomic Energy Authority, London, United Kingdom

Some Examples of Release of Materials and Sites, Including Measurement Techniques

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 104-109) (1984)

Many test reactors and some power reactors have already been decommissioned and partially or entirely dismantled. Although some materials are classified as radioactive waste, others may be considered as ordinary waste or reutilized for nuclear or nonnuclear work. There is no international recommendation on activity limits for the unconditional reutilization of material. In Germany the limits applied for dismantling the Otto Hahn reactor were 10(E-4) uCi/g and and 10(E-5) uCi/sq cm. In France there are no statutory limits for release for public use. Each case is submitted for authorization to the Service Central de Protection Contre les Rayonnements Ionisants, the central authority in France for protection against ionizing rays, a department of the Ministry of Health which decides on the characteristics of the waste in question. Examples of releases in Germany (GKSS), France (CEA), and the United Kingdom (UKAEA) are given. In Germany, the reactor on the NS Otto Hahn was dismantled between 1980 and 1982, after 10 years' operation. The secondary circuit, with low contamination, was decontaminated. Monitoring of the surface activity before unconditional release required more than 1 million measurements. In September 1982 the ship was resold and in the following months was equipped with a diesel engine. Also described are the dismantling of some French reactors, in particular, Pegase and GL. In the case of the latter,the building and the equipment, such as the gantry, were reused for non-nuclear work. Some materials, such as steel and copper pipes, can be considered as uncontaminated. In the Pegase reactor, the vessel and tanks were reused after decontamination, for the temporary storage of irradiated fuels. The steel loops were sent, after decontamination, to the smelting works. At the Harwell site, a series of low-power reactors built between 1947 and 1965 have since been decommissioned and the buildings reused for non-nuclear work. This was the case, in particular, with BEPO, a 6.5 MW air-cooled-graphite reactor, and with LIDO, a 300 kW swimming pool reactor. (Auth)(JWF)

96

Cregut, A., and A.R. Gregory, Commissariat a l'Energie Atomique, Centre de Marcoule, Bagnols-sur-Ceze, France; Central Electricity Generating Board, Generation, Development, and Construction Division, Gloucester, United Kingdom

Decommissioning of Nuclear Power Stations in Community Countries Carried Out or Projected

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 15-21) (1984)

To date, the many small units and few large plants which have been definitively shut down have been handled on an ad hoc basis. The decommissioning of large plants such as nuclear power stations merit a different

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approach requiring the introduction of measures and procedures allowing them to be dealt with efficiently; this efficiency would imply concern for optimum economy of operations while respecting the safety rules inherent in nuclear energy. This paper examines requirements regarding the tactical and policy elements to guide plant owners in their decisions and choices; efficient tools, equipment and processes; and provides information gained from experience of decommissioning already carried out. While it is true that experience acquired to date does not permit a definitive policy and codes and guidelines to be drawn up, it nonetheless makes a significant contribution towards decommissioning options and techniques. (Auth)(JWF)

97

DaCosta Cabral Gannao, L., F. De Buck, M. Leconte, E. Kirchner, P. Drucke, M.H.E. Larcombe, and J.R. Halsall, Ateliers de Constructions Electriques de Charleroi, Charleroi, Belgium; Gesellschaft fuer Systemtechnik mbH, Essen, Federal Republic of Germany; University of Warwick, Coventry, United Kingdom

Remote Operation in Decommissioning

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 267-280) (1984)

In order to reduce radiation exposure and occupational hazards during decommissioning tasks in nuclear facilities, and to allow intervention at an early stage after a shutdown and in situations of accident, remotely controlled and, during execution of specific operations, autonomous systems are needed. This paper presents the results of two research programs on the subject of remote operation and robotics. One of these programs, "Review of Systems for Remotely Controlled Decommissioning Operations," conducted in close cooperation by GST and ACEC, was aimed at analyzing the tasks arising, at the review of applicable existing equipment, and first conceptual studies of needed remotely operated equipment. Based on the evaluation of tasks and existing equipment, recommendation for future research and development was made. The second program, "Possible Advances in Remotely Controlled Operations in Hostile Environments," conducted by the University of Warwick, concentrates mainly on advanced control and data transmission systems. This study reviews the present state-of-the-art in remote controlled robotics (REMCON) and gives total systems predictions for possible future applications within the nuclear industry. In decommissioning tasks, the main fields of application to be considered are: (1) monitoring by visual inspection and radiation or position measurement, (2) decontamination of assemblies or of work space, (3) dismantling of concrete or metal structures, and (4) possibly treatment and transport of resulting debris. It is clear that in terms of human life and health, the use of remote control or robotic devices, in nuclear industry in general, and in decommissioning tasks in particular, is a necessity. Results of both studies confirm that most of the technologies needed to develop future REMCON systems exist as of today. In fact, with the exception of control aspects, the technology requirements are not excessive. (Auth)

98

Emel'yanov, I.Y., A.I. Klemin, V.V. Taratunin, V.S. Emel'yanov, and V.B. Morozov

Estimation of the Residual Operational Lifetime of Uranium-Graphite Channel Reactors

Soviet Atomic Energy 52(3):157-163 (1982, March)

The history of the construction of reactors in this country and abroad has passed the 30-yr mark. Problems related to the final shutdown of nuclear reactors whose further use is, for some reason, impossible or of no purpose have appeared. The extent to which these problems are important is indicated by the fact that during the last 20 years according to MAGATE data, 65 reactors have already been shut down worldwide. The most important problem is to make an objective estimate of the residual operating life of a reactor, i.e. the length of time it was used, beginning with the present time and up to the time the reactor is removed from service for final shutdown or for major repairs. This article presents a method for the estimation of the residual operational lifetime of uranium-graphite channel reactors.

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Evans, J.C., E.L. Lepel, R.W. Sanders, C.L. Wilkerson, and W. Silker, Pacific Northwest Laboratory, Richland, WA

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Long-Lived Activation Products in Reactor Materials

PNL-4824; NUREG/CR-3474; 172 pp. (1984, August)

This report presents the results of a study sponsored by the U.S. Nuclear Regulatory Commission (NRC). The purpose of this study was to investigate the effect of nuclear activation on major reactor construction materials with particular emphasis placed on isotopes of importance to decommissioning and waste disposal activities. This information is of importance in the design of decommissioning strategies and in the formulation of regulatory guidelines for implementing those strategies. A thorough assessment was made of all potentially important nuclear activation pathways for more than 40 isotopes with half-lives ranging from a few years to tens of millions of years for incorporation into a computer model so that no important activation product would be overlooked. Finally, samples of activated material were obtained from several operating or decommissioned reactors and were subjected to radiochemical assay for selected long-lived isotopes.

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Advisory Committee on Reactor Safeguards, Combined Subcommittees on Reactor Radiological Effects and Humboldt Bay Nuclear Power Plant, Unit No. 3 - Meeting

Federal Register 49(161):32921 (1984, August 17)

The ACRS Subcommittee on Reactor Radiological Effects and Humboldt Bay Project will hold a joint meeting on September 10, 1984 at the Eureka Inn, Eureka, CA. The Subcommittees will review plans by the Pacific Gas and Electric Company for decommissioning the Humboldt Bay Nuclear Power Plant, Unit No. 3. (JWF)

101

Fenster, D.F., J.P. Schubert, S.D. Zellmer, W. Harrison, D.G. Simpson, and J.S. Busch, Argonne National Laboratory, Argonne, IL

Radioactive Waste Isolation in Salt: Peer Review of the Office of Nuclear Waste Isolation's Plan To Decommission and Reclaim Exploratory Shafts and Related Facilities

ANL/EES-TM-258; 31 pp. (1984, July)

The following recommendations are made for improving the Office of Nuclear Waste Isolation's plan for decommissioning and reclaiming exploratory shafts and other facilities associated with site characterization: (1) Discuss more comprehensively the technical aspects of activities related to decommissioning and reclamation. More detailed information will help convince the staff of the U.S. Nuclear Regulatory Commission and others that the activities as outlined in the plan are properly structured and that the stated goals can be achieved; (2) Address in considerably greater detail how the proposed activities will satisfy specific federal, state, and local laws and regulations; (3) State clearly the precise purpose of the plan, preferably at the beginning and under an appropriate heading; (4) Also under an appropriate heading and immediately after the section on purpose, describe the scope of the plan. The tasks covered by this plan and closely related tasks covered by other appropriate plans should be clearly differentiated; (5) Discuss the possible environmental effects of drilling the exploratory shaft, excavating drifts in salt, and drilling boreholes as part of site characterization. Mitigation activities should be designed to counter specific potential impacts. High priority should be given to minimizing groundwater contamination and restoring the surface to a condition consistent with the proposed land use following completion of characterization activities at sites not chosen for repository construction; and (6) Define ambiguous technical terms, either in the text when first introduced or in an appended glossary.

102

Gallenberger, H., and U. Loschhorn, Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, Federal Republic of Germany

"Safe Containment" of the Niederaichbach Nuclear Power Station (KKN)

CONF-821005; International Decommissioning Symposium - 1982, Proceedings of the U.S. Department of Energy's Remedial Action Program/OECD Nuclear Energy Agency Conference, Seattle, WA, October 10-14, 1982, 868 pp.; (pp. IV-93 - IV-105) (1982, October)

The 100 MW(e) Niederaichbach Nuclear Power Station (KKN), located in the Federal Republic of Germany, and equipped with a CO2 cooled and D2O moderated pressurized tube reactor, stopped operation for good in late July 1974 when its decommissioning was decided. The considerations made on the individual steps of decommissioning, taking into account the necessary techniques and costs, led to transferring the plant initially into the safe containment condition with simple monitoring, treating it in this way as a model case in the Federal Republic of Germany, to be followed by complete disposal at some later date. At present, KKN is in the authorized condition of "safe containment." Planning work on disposal has been nearly terminated and the licensing procedure for disposal under the Atomic Energy Act has been initiated. It is intended to perform complete disposal within the years to come. (Auth)

103

Gans, G.M., Jr., Burns and Roe Industrial Services Corporation, Paramus, NJ

Engineering and Planning for Decommissioning of Nuclear Power Plants

ASME-82-NE-22; CONF-820705; Proceedings of the Joint American Society of Mechanical Engineers and American Nuclear Society Engineering Conference, Portland, OR, July 25-28, 1982 (1982, July 26)

With the publication of NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities" in January, 1981, the U.S. Nuclear Regulatory Commission staff has put the industry on notice that the termination of operating licenses and the final disposal of physical facilities will require the early consideration of several options and approaches. This requires the preparation of comprehensive engineering and planning documents for the selected option at the end of useful life. The paper includes a discussion of the options available and the primary aspects of decommissioning. The major emphasis of documents, the general approach to be followed, and special considerations to be taken into account when performing the detailed engineering and planning for decommissioning, as the end of life approaches and actual physical disposal is imminent are included. (Auth)(RCF)

104

Goddard, A.J.H., T.D. MacMahon, and M. Peselli, Imperial College of Science and Technology, London, United Kingdom; Nucieco, S.P.A., Milan, Italy

Activation of Steel Components

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 61-74) (1984)

Trace elements leading to long-lived induced gamma activity have been assessed in selected reactor steels. Concentrations of Mo, Ni, Nb, Co, Ag, Eu, Sm, and Ho have been measured. Particular attention has been paid to the detection limits of various techniques. Three techniques have been applied to Nb determination and concentrations close to the detection limit of 5 ppm measured in a number of steels. Concentrations of Ag in the vicinity of 1 ppm were observed in all steels analyzed. The second aspect of the work described, concerns evaluation of gamma emitting nuclides in structural materials of the Garigliano BWR power plant. The trace element composition of samples of vessel steel have been measured. A series of detailed two-dimensional neutron transport calculations have been carried out and, with the aid of the operating history, the time dependent flux leading to activation of vessel, liner, and thermal shield estimated. The dose rate at the center of the reactor vessel has been calculated as a function of the time following shutdown. The form of the contribution to dose rate from the vessel differs from that of the liner and thermal shield, due mainly to the need to make pessimistic assumptions of steel composition in the absence of trace element analysis for these latter two components. (Auth)

105

Gregory, A.R., and A. Cregut, Central Electricity Generating Board, Generation, Development, and Construction Division, Gloucester, United Kingdom; Commissariat a l'Energie Atomique, Centre de Marcoule, Bagnols-sur-Ceze, France

Factors To Be Considered in Selecting a Decommissioning Strategy

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EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 33-40) (1984)

The introduction outlines the scope of the work that will be carried out during the three stages of decommissioning a nuclear power station although the content of each stage may vary somewhat according to the reactor system and country, and in particular whether defuelling forms an integral part of Stage 1. Some important factors to be taken into account are the nature and quantities of contaminated material and neutron activated materials, and the techniques required to dismantle the plant and manage the waste. Timescales for carrying out each stage are discussed for water cooled and gas cooled reactor systems. The radiological protection benefits from delaying decommissioning, limiting effects of the long lived radioactive isotopes, are noted. It is suggested that three courses of action be considered: (1) complete stages 1, 2, and 3 as an ongoing project within 10 to 15 years from shutdown, (2) complete stages 1 and 2 within 7 to 10 years from shutdown but defer stage 3 up to 50 years or longer, (3) complete stage 1 and defer stages 2 and 3 for up to 50 years or longer. In considering these options attention must be paid to the long term integrity of buildings and systems. It is concluded that, following a definitive shutdown, the reactors will be defuelled as soon as reasonably practicable. A decision to proceed to stages 2 or 3 depends on safety, technical, economic considerations as well as national policy and public opinion. (Auth)(JWF)

106

Hirashima, S., Central Research Institute of Electric Power Industry, Tokyo, Japan

Study Concerning Decommissioning of Nuclear Facilities Overseen by the IAEA in the United States and Major European Countries

Denryoku Chuo Kenkyusho Hokoku 582003:1-13 (1983, January)

The purpose of this study was to examine IAEA's policies and recommendations regarding the decommissioning of nuclear facilities and to compare regulations, financing methods, policy, and research and development concerning reactor decommissioning in European countries to the United States. The IAEA has been investigating reactor decommissioning since 1973. The IAEA technical committee met in 1975 and 1977, and an international symposium was held in 1978. The report, "Various Factors Concerning the Decommissioning of Inland Nuclear Facilities" was published in 1980. In Japan, reactor decommissioning has received considerable attention recently. A report by the Decommissioning Countermeasures Committee was published in March, 1981. Regulating and financing decommissioning operations vary considerably from country to country. Main features of the decommissioning policies are indicated. Many studies have been done in foreign countries concerning the cost of decommissioning and decontamination (D&D) of nuclear facilities and methods of providing funding for the work. In Japan, it would be desirable to establish the technical standards for decommissioning activities as well as legislation for financing D&D operations. (PTO)

107

Hohn, H., G. Romes, H. Barnert, and J. Singh, Kernforschungsanlage Juelich GmbH, Juelich, Federal Republic of Germany

Design of Primary Circuits for AVR-2 with Special Attention to Maintenance, Repair and Decommissioning

CONF-830636; Jahrestagung Kerntechnik '83 (Nuclear Technology '83), Proceedings of a Conference, Berlin, Federal Republic of Germany, June 14-16, 1983; (pp. 651-654) (1983)

The development work on HTR nuclear research reactor design by Julich GmbH is described. Components and the reactor housing are held in two separate, steel pressure vessels. In addition to coaxial flow in the circuit, there is an isolated gas chamber between the container wall and the components section for reducing contamination and facilitating access.

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Holmes, A.

Decommissioning Costs: How Much Will Be Enough

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Energy Economics 34:2-4 (1984, August)

The problems of providing for the cost of decommissioning a nuclear power plant are discussed. The results are shown of a questionnaire sent to all utilities which own and operate nuclear reactors. Three stages in the dismantling process are considered. For one specific reactor, to be decommissioned by immediate dismantlement, a detailed summary of estimated costs is given. The uncertainties due to lack of experience, and the possible effect of high decommissioning cost on the economic competitiveness of nuclear power, are discussed.

109
Hudgins, C.

Industry and Its Critics Agree NRC Decommissioning Figure Too Low

Nucleonics Week 26(17):8-10 (1985, April 25)

Some of the nuclear industry's most vocal promoters and critics have allied themselves, at least in argument, to send a message to NRC that the $100-million it has suggested be set aside for decommissioning nuclear power plants is too small. The $100-million proposed by NRC in its rule proposal is in 1984 dollars and is adjusted for inflation at twice the change in the Consumer Price Index. The figure is derived in part from the 1978 "definitive" study on decommissioning by Battelle Pacific Northwest Laboratory. Recommendations made by Public Citizen/Environmental Action concerning 70 reactors expected to be shut down by 2010 are: decommissioning funds should be held in a segregated external fund with insurance against premature shutdown. Cost estimates should be revised every five years. The U.S. Office of Technology Assessment should undertake an updated and independent study of decommissioning costs and methods because the Battelle study is outdated and done by a group with ties to the industry. Stockholders should bear the brunt if costs escalate, not the ratepayers who have never benefited from the power generated. A full environmental impact statement should be prepared at the time decommissioning plans are proposed, near the end of the operating life of a reactor, and the pre-construction environmental impact statement should at least address the decommissioning question. Entombment should be prohibited as a decommissioning method. A 50-year limit should be placed on temporary storage before dismantlement, in contrast to an NRC suggestion of a 30- to 50-year period. Long-lived activation products such as nickel-59 or niobium-94, as well as chemical decontamination wastes, should be excluded from low-level waste sites. Chelating agents used in decontamination should be stored in monitored aboveground facilities until more is known about them. The maximum allowable worker radiation dose should be reduced at least tenfold and a worker registry established to monitor permanent and temporary workers. (Auth) (CAC)

110
Ito, N., Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Development of Techniques for Dismantling Nuclear Reactors

Denki Kyokai Zasshi 723:43-50 (1984, January)

The reactors constructed in the latter half of the 1960s in Japan must now, after 20 years of operation, be considered for decommissioning. The safety of decommissioned reactors must be maintained permanently, and the vacated site must be reused. Outlined are the reactor decommissioning measures that were adopted in 1982 in the long-term plan for the development and utilization of nuclear energy by the Japanese Atomic Energy Commission. It was decided to advance the research on engineering safety and to carry out the technical development for the decommissioning of nuclear reactors, using the Japan Power Demonstration Reactor, operated by the Japan Atomic Energy Research Institute (JAERI). The task of dismantling the reactor will involve working with intense exposure to radiation, heavy metallic and concrete structures, and operating within a narrow working space. The report also includes technical developments, such as engineering of dismantlement systems, techniques for evaluating contained radioactivity, dismantlement methods and equipment, development of decontamination techniques, and techniques for the treatment, storage, and disposal of radioactive wastes involving remote operations.

111
Johnson, G.L., University of Utah, Salt Lake City, UT

Procedures, Costs, and Rate Structures for Decommissioning Nuclear Reactors

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Journal on Energy Law Policy 5(2):245-271 (1984)

Nuclear plant licensing procedures do not require applicants, usually utilities, to include a program for decommissioning, which means that utilities can delay developing these plans until the plant's useful life is ending. Because this can be harmful to public health and the environment and penalize future ratepayers, the U.S. Nuclear Regulatory Commission (NRC) is considering comprehensive criteria for license application. The goals of decommissioning procedures should be for the protection of human health and the environment, a provision for financing decommissioning costs, and a uniform and equitable rate structure. After reviewing current procedures, the author recommends a coordinated information system on all facilities and sites where radioactive materials are used or stored, a standardized decommissioning plant as part of the licensing procedure, and an annual tax allowance of recommissioning funds to be applied to decommissioning costs. Costs should not override health and environmental protection in decisions to dismantle or store radioactive materials.

112
Kernkraftwerk Lingen GmbH, Lingen, Federal Republic of Germany

KWL Annual Report 1983

INIS-mf-9235; 18 pp. (1983)

The application for decommissioning comprises the shutdown of the plant, methods for safe shielding of the nuclear section, and a modification in the utilization of the conventional plant sections. The planning documents are worked out by the Nuklear-Ingenieur-Service GmbH, Hanau. The activities for the Euratom research programs have been completed by KWL. The final report on the determination of the activation of the biological shield is available. The processing of the enriched uranium originating from unirradiated Fe as well as the conversion to UF6 has been terminated. All spent fuel elements have been transported to BNFL. The joint work arrangement between KWL and the VEW power plant Emsland has been altered.

113
Kerr, G.W., U.S. Nuclear Regulatory Commission, Washington, DC

Memorandum of Understanding (MOU) Between U.S. NRC and the State of Illinois

Federal Register 49(95):20586-20587 (1984, May 15)

Section 274i. Of the Atomic Energy Act of 1954, as amended, allows the Commission to enter into agreements with the States "to perform inspections or other functions on a cooperative basis as the Commission deems appropriate." Section 274i. MOUs differ from agreements entered into between NRC and a State under the "Agreement State" program; the latter is accomplished only by entering into an agreement under section 274b. Of the Atomic Energy Act. A 274i. MOU can be entered into by a State whether or not it has a 274b. agreement. This MOU, signed by the NRC and the State of Illinois, provides principles of cooperation between the State and NRC in areas of concern to the State. The MOU provides the basis for detailed subagreements in areas such as low-level radioactive waste treatment, storage and disposal, emergency preparedness, nuclear facility siting and operation, and decommissioning of nuclear facilities. Under MOU, the State and NRC have committed to consult regularly and cooperate in devising procedures to minimize duplication of effort and avoid delays in decisionmaking. (JWF)

114
Knotts, J.B., Debevoise and Liberman, Washington, DC

Insurance for Decontamination and Decommissioning

Nuclear Insurance Issue, Proceedings of an Atomic Industrial Forum Conference, Washington, DC, February 13-16, 1983 (1983)

The U.S. Nuclear Regulatory Commission's (NRC) Advance Notice of Proposed Rulemaking on mandatory property insurance for decontamination is examined. The NRC will require licensees to maintain all primary and excess coverage available from both principal sources and will give priority in all such policies to decontamination expense. The pros and cons of having alternative and competing sources of nuclear property insurance are discussed. In addition, the issue of insurance for premature decommissioning of nuclear plants is studied.

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Krapnick, M.

UCLA Has Decided To Decommission Its Research Reactor

Nucleonics Week 25(26):9-10 (1984, June 28)

UCLA has decided to decommission its research reactor saying that spending more money on maintenance, operation, and fuel conversion could not be justified in light of the "declining importance" of the reactor to the university's academic programs. The UCLA reactor, a 0.1 MW(t) Argonaut reactor using high-enriched uranium fuel, was licensed in 1960. The university applied for renewal of that license in 1980. A first step in decommissioning the reactor will be for UCLA to return to DOE over 3 kg of irradiated fuel and about 1 kg of fresh fuel now at the reactor.

116

Lasch, M., K.H. Schaller, W. Stang, and G.V.P. Watzel, Kernkraftwerk Gundremmingen Betriebsgesellschaft GmbH, Gundremmingen, Federal Republic of Germany; Commission of the European Communities, Brussels, Belgium; Rheinisch-Westfalisches Elecktrizitatswerk AG, Essen, Federal Republic of Germany

Estimation of Radioactive Waste Quantities Arising During Decommissioning

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 75-89) (1984)

The quantities of radioactive waste arising from the decommissioning of nuclear power plants, which are in operation, under construction, or ordered in the countries of the European Community, have been roughly estimated. As compared to earlier evaluations, measurements and decontamination work at the 237 MW(e) Boiling-Water Reactor KRB-A Gundremmingen, which has been shut down since 1977 after 11 years of operation, allowed a more precise forecast in two fields, penetration of contamination in walls and floors, and decontamination of metallic components and piping on a large scale. The penetration of contamination has been measured at selected locations. The surfaces of almost all of the restricted area are covered by a protective coating as are most of the European nuclear power plants. 90% of the activity has been found to have accumulated in the coatings. An extrapolation to the total plant surface showed that only about 500 mg of waste would be generated during dismantling, in the process of decontaminating walls and floors to values for unrestricted release. Electrochemical decontamination of metallic components to unrestricted release has been demonstrated successfully at KRB-A on a large scale. The treatment of the decontamination solutions allowed estimation of the quantities of secondary waste produced in the event of a decontamination of the whole machine-house equipment. On the supposition that, on the average, reactors will be dismantled definitively after a decay time of at least 30 years after final shutdown, the arising quantities of medium and low-level radioactive waste have been estimated for the different types of reactors. Totaling the quantities shows, that only after the year 2050, an annual quantity would be reached which is of the same order of magnitude as the waste produced annually by normal reactor operation in the years 1990 to 2000. (Auth)(JWF)

117

Lauterbach, U., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

NS Otto Hahn: Contamination Measurements After Decommissioning and Release for Further Use

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 55-63) (1983, January 26)

Gamma spectrometrical investigations during shutdown showed mostly Co-60 in the contaminated regions. The scintillation dosimeter developed at the PTB has been used for measuring the environmental radiation. Material samples taken at random have been inspected gamma spectrometrically in order to prove the reliability of the contamination measurements accompanying the shutdown work.

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Lawton, H., United Kingdom Atomic Energy Authority, Windscale Nuclear Power Development Laboratories, Seascale, United Kingdom

E Minimis Maxima or the Work of the UKAEA Laboratories at Windscale, Part 2

Nuclear Engineering International 24(6):164-169 (1983, November-December)

Work carried out at Windscale Nuclear Laboratories is described which embraces AGR technology, including decommissioning studies in preparation for the dismantling of the WAGR.

119

Lettnin, H.K.J., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

NS Otto Hahn Decommissioning Concept

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 17-24) (1983, January 26)

After taking into consideration the NIS study, a decision was made to eliminate the nuclear portion of the drive system from the NS Otto Hahn, which means removal of all radioactive components. The entire reactor plant had to be disassembled, with the exception of the safety containment and the concrete portions of the secondary protection system and the service pool. Radiological protection of personnel as well as environmental protection were taken into account. Components that had properties which made them difficult to decontaminate were stored in casks and special containers. (PTO)(RFC)

120

Manion, W.J., and R.W. Ramsey, Nuclear Energy Services, Inc., Danbury, CT

Decontamination, Decommissioning and Remedial Actions: Progress and Developments in the Stewardship of Nuclear Facilities

IAEA-CN-43/189; STI/PUB-648; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 2, 538 pp.; (pp. 115-123) (1984)

In the next decade, decontamination and restoration of nuclear energy facilities and sites after shutdown must expand greatly. The accumulated number of sites that are restricted in their use due to the presence of radioactive contamination will increase exponentially as older plants are shutdown. The need for advanced planning and a reserve of resources to dispose of such facilities without increased hazard from neglect or burdening future generations with their disposition is recognized by the international nuclear community. Two major international bodies have recently focused attention on the problem of disposing of decommissioned facilities. The International Atomic Energy Agency convened a meeting of the Technical Committee, which held discussions on the Decommissioning of Nuclear Facilities: Decontamination, Disassembly and Waste Management in Vienna in April 1982. In addition, the U.S. Department of Energy, in cooperation with the Nuclear Energy Agency of the Organization for Economic Co-operation and Development, held an international symposium on Decommissioning in Seattle in October 1982. Both these meetings considered active programs on the development of policy, regulations and standards, decommissioning technology and experience and planning of decommissioning projects. The proceedings of these two meetings are summarized; the conclusion reached is that the nuclear community worldwide is developing the policies, technology and planning necessary to deal with the problem of decommissioned nuclear facilities in a responsible manner.

121

May, S., D. Piccot, L. Bergemann, W. Harbecke, and G. Loercher, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France; Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Federal Republic of Germany; Kernkraftwerk Lingen GmbH, Lingen, Federal Republic of Germany; NIS Nuklear-Ingenieur-Service GmbH, Frankfurt, Federal Republic of Germany

Activation of Biological Shields

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EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 47-60) (1984)

Knowledge of the quantities of radioactive waste resulting from the dismantling of the concrete biological shields of nuclear reactors is very approximate because there is little accurate data available on the composition of the concrete. It is possible to calculate the residual radioactivity in the concrete from nuclear reactors if the amounts of the elements which give rise to long-lived radionuclides, and in particular chlorine, calcium, nickel, cobalt, niobium, europium, and samarium are known accurately. The highly effective techniques of neutron activation analysis were used to determine the quantities of 29 elements in 21 concrete samples from reactors in the European Community. Research was conducted on the Lingen (KWL) and Gundremmingen (KRB-A) reactors. The method employed consisted of measurements conducted on concrete samples and calculations based on the composition of the concrete determined by activation analysis. The measurements made and the results of the calculations are in reasonable agreement. (Auth)

122

McLeod, N.B., and Y.M. Park, NUS Corporation, Gaithersburg, MD

Status of Decommissioning Ratemaking Practice

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (p. 42); Transactions of the American Nuclear Society 45:4 (1983)

Several years ago it became generally recognized that the cost of ultimately decommissioning nuclear power plants represented a future financial liability that was not generally being acknowledged in utility rates. At that time, considerable debate arose as to the proper ratemaking practices for ultimately providing the funds when needed for decommissioning, generally several decades in the future. In the intervening years, actual ratemakings have narrowed the issues under debate and in some ways have generated a consensus. However, there is virtually no area or issue on which unanimity prevails, except the important overall consensus that decommissioning appears to have been generally accepted as a legitimate cost element that should be borne by the ratepayers who utilize the output of the plant. There continues to be, and via the ratemaking precedents already established there is likely to continue to be, a considerable variance within each of a number of individual areas, and a quite remarkable diversity of decommissioning ratemaking practice. This paper outlines the more important areas and issues and summarizes the typical practices that have evolved.

123

Decommissioning: Another Facet of Nuclear Power

Monitor 3(26):1, 8 (1983, December)

The complexity and interest of the decommissioning issue have become evident by the large number of rulemaking, research, and litigatory activities underway at the U.S. Nuclear Regulatory Commission, the Energy Information Administration, Internal Revenue Service, the U.S. Environmental Protection Agency, and the Federal Energy Regulatory Commission (FERC). Of the available options (dismantlement, mothballing, and entombment), immediate dismantlement is the cheapest methodology. It then remains to be decided how the cost of decommissioning will be borne. Although there is general agreement that the cost should be borne by the ratepayer, there is gross uncertainty as to what the cost will be. In a case pending before the FERC, Vermont Yankee Nuclear Power Corporation filed a proposal to begin collecting the estimated cost of decommissioning. The estimated cost to dismantle the facility in the year 2007 is $422.6 million. (MFB)

...any's Karlsruhe HWR To Be Decom...ned

Nuclear News 27(8):96-97 (1984, June)

The Multipurpose Research Reactor (MZFR), a 50-MW(e) heavy-water-moderated reactor which has operated at the Karlsruhe Nuclear Research Center in Germany since 1965, is to be shut down in May. The plan was one of several early demonstration projects

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undertaken in Germany and was the prototype for the pressure vessel-type of HWR. The decommissioning date was advanced due to a requirement from the licensing authority for inspections and possible backfitting to meet the latest safety standards, which could not be economically justified for the short remaining period of operation. For 15 years, the plant has recorded an average availability of 79% and has generated nearly 6 billion kW-hr of electricity, as well as supplied steam for heating at the Karlsruhe Center. (Auth)

125
Public Interest Effort Surveys Decommissioning Tactics and Funding

Nucleonics Week 26(17):10-12 (1985, April 25)

This article contains a chart taken from a two-year study of decommissioning, "Dismantling the Myths About Nuclear Decommissioning," by nuclear critics Public Citizen/Environmental Action. According to those groups and to several industry groups, it is the only listing of its type. The information is current, through the end of 1983. It is based on questionnaires completed by utilities as well as from telephone calls to those utilities and state regulatory groups. In addition to commercial reactor information, the chart includes some information on DOE reactors. In some cases, incomplete information has resulted from the fact that reactors had not yet been licensed, therefore, funding mechanisms for decommissioning were not yet in place. The methods of decommissioning are explained in footnotes accompanying the chart. The financing methods include internal unsegregated funding (IUF), internal segregated funding (ISF), and external sinking funding (ESF). (Auth)

126
Ogura, S.I., Science and Technology Agency, Tokyo, Japan

Plan for Dismantling the Japan Power Demonstration Reactor (JPDR) - Aiming at Establishing the Decommissioning Techniques for Reactors

Ohm 70(3):44-48 (1983, March)

The Japan Atomic Energy Research Institute submitted a notice dated December 9, 1982 on the dismantling of the nuclear reactor facility (JPDR) in Tokai Laboratory to the Director of Science and Technology Agency, based on the law concerning the regulation of nuclear raw materials, nuclear fuel materials and nuclear reactors. In this report, the background and the outline of the plan concerning the dismantling of the JPDR are described. In Europe and the United States already more than 30 power reactors have finished operation, and the necessary measures have been taken. In Japan, the JPDR is the first case. To prepare for the decommissioning of large power reactors, the measures to be taken have been studied in various countries and also in IAEA and OECD. The measures are divided into three, (1) closure of nuclear facilities and appropriate management, (2) isolation of radioactive substances by shielding and other methods, (3) dismantling and removal of structure. It is planned to utilize the dismantling of the JPDR for developing the techniques and facilities used for decommissioning. It was judged that dismantling according to the plan would not cause any hazard.

127
Palmer, R.E., and R.R. Buta, Bechtel Power Corporation, Gaithersburg, MD

Updating of Decommissioning Cost Estimates

Transactions of the American Nuclear Society 46:561-562; CONF-840614; Proceedings of an American Nuclear Society Annual Meeting, New Orleans, LA, June 3-7, 1984; (pp. 561-562) (1984, June)

The costs associated with the projected decommissioning of a nuclear power facility at the end of its operating life are extensive and increasing, and are of growing importance to both the owner(s) and the rate payers. The impact of decommissioning cost estimates is reflected in owner accounting issues such as depreciation, salvage, reserve versus sinking fund, taxes and cashflow. The practice of adjusting an estimate for escalation (effects of inflation) on a periodic basis, without an examination of cost components relative to today's technical knowledge base, operating experience, and regulations, could result in an understatement of current costs. This paper addresses the following questions: (1) Does escalation of prior year estimates to current year dollars understate probable costs? and; (2) What cost categories contribute to a variance between older, escalation-adjusted studies and recently completed estimates? This study is centered on the DECON (immediate dismantlement/prompt removal) method for decommissioning, which is the approach viewed by the U.S. Nuclear Regulatory Commission (NRC) as the only permanent disposition of an operating plant. Twenty-eight boiling water reactor and pressurized water reactor decommissioning studies and estimates, both generic and site specific, completed during the period 1975 to 1983 were reviewed. The research strongly suggests that decommissioning estimates made in earlier years, and updated only for inflation, result in an understatement of current costs. This is due to changes in industry standards, an expanded scope of decommissioning activities, and increased knowledge of operating plant characteristics. (CAC)

128

Paton, A.A., P. Benwell, T.F. Irwin, and I. Hunter, Taylor Woodrow Construction Limited, Southall, Middlesex, United Kingdom

Study of Design Features of Civil Works of Nuclear Installations Facilitating Their Eventual Refurbishing, Renewal, Dismantling or Demolition

TWC-014D-84-2568; 101 pp. (1984, March)

This report describes a study that has been carried out to identify civil engineering features which could be incorporated in future gas-cooled and light water-cooled nuclear power plants to facilitate their decommissioning. The report reviews the problems likely to be met in decommissioning present-day nuclear power plants and concludes that there is a number of such features which could be introduced in future designs to overcome or eliminate the problems. The report identifies and describes these features and recommends that further work be carried out to confirm their feasibility. The study briefly considered the possibility of refurbishing nuclear plants and concluded that this is not a realistic option in present circumstances.

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Petrasch, P., M. Seidler, and W. Stasch, NIS Nuklear-Ingenieur-Service GmbH, Hanau, Federal Republic of Germany

Closing Down and Dismantling of Research - Material Testing and Teaching Reactors

NIS-633; 395 pp. (1983, February)

This study considers the following aspects of decommissioning and decontamination (D&D) of reactor facilities in the Federal Republic of Germany: (1) determination of mass and radioactivity of the parts to be dismantled; (2) identification of future tasks of research and development; (3) estimation of radiation exposure for workers conducting dismantling tasks; and (4) determination of cost for closing-down and dismantling research reactors. A total of 22 research reactors, materials testing reactors, and training reactors are considered in this study. Only those components that belong directly to the reactor proper or auxiliary and service plants are to be dismantled. The reactor buildings will only be dismantled if they are a direct reactor component (e.g. serving as a biological shield). The total waste quantity generated by closing-down and dismantling all research reactors considered in this study is about 25,200 Mg, of which 720 Mg are radioactive wastes. Planning for and carrying out the shutdown and dismantlement of all research reactors will require about 4870 man-months. The total cost will be about 86.4 million DM. There are vast will have to be disposed of in the case of the differences between the individual research reactors. The D&D of the Siemens training-reactor 100 (SUR-100) will result in the generation of only 10 Mg of waste, of which a very small portion is radioactive. In the case of the Neuherberg research reactor (FRN), about 3500 Mg of waste will be generated, of which about 94 Mg will be radioactive waste. The work needed per reactor varies from 26 man-months for the SUR-100 to about 740 man-months for the FRN. Costs for shutdown and dismantlement range from 0.4 million DM for the SUR-100 to 13 million DM for the FRN. (PTO)

130

Pilalis, L.E.

Updating Nuclear Decommissioning Cost Estimates

Public Utilities Fortnightly 114(8):56-58 (1984, October 11)

In the article, "An Analysis of Decommissioning Cost Estimates for Nuclear Operating Plants," the authors

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presented a comprehensive summary for considerations of developing up-to-date estimates of nuclear power plant decommissioning costs. However, this summary focused exclusively on the factors that can affect increases in decommissioning costs at higher rates than the escalation rates of conventional cost indices. In his opinion, Buta and Palmer omitted any consideration of the following two areas that affect both the updating and the development of nuclear power plant decommissioning cost estimates: (1) developments in the areas of technology, operational experience, financing, and regulation of nuclear power plant decommissioning that could lower nuclear decommissioning costs and retard the escalation rate of individual decommissioning cost categories; and (2) inclusion of sizeable contingency factors in cost estimates that intend to address the uncertainty of future events in the operational and regulatory environment for nuclear power plant decommissioning.

131

Pinjawka, K.D., and P.D. McClain, Arizona State University, Center for the Environment, Tempe, AZ; Arizona State University, School of Public Affairs, Tempe, AZ

Agenda Setting and "Non-Decisionmaking": Decommissioning Nuclear Generating Stations

Proceedings of the Western Political Science Association Meeting, Las Vegas, NV, March 28-30, 1985 (1985, March)

Decommissioning has emerged as an issue for policy inquiry for the following reasons: (1) while the recently proposed guidelines by the NRC were a step in the right direction, many critical areas associated with the decommissioning process were excluded; (2) there is evidence that problems occurred at the few commercial plants and defense reactors that have been decommissioned; and (3) public concerns are increasingly being expressed over the difficulties in financing dismantlement, and over safety concerns at sites where dismantlement is proposed. Decommissioning has remained a non-issue because: (1) decommissioning is generally viewed as a future problem, not as a present problem; (2) decommissioning is viewed as a technical and management problem rather than one involving inherent environmental values; and (3) other, more pressing, safety issues such as high-level waste management, when resolved, will reduce decommissioning problems to a more manageable set. Effective implementation of decommissioning programs will have to address public acceptance questions, an area which as not been addressed in the recently proposed guidelines. The apparent conflicts in the implementation of policy and lack of foresight could result in serious delays in decommissioning and serious environmental, regulatory, and safety problems for future generations. By classifying decommissioning as a financial "condition" rather than as a risk management and waste management "problem," the NRC has virtually ensured that it will not be high on the "public" or "formal" agenda. Decommissioning, which is currently taking place, is clearly setting its own agenda with the critical decisions being made by the private sector, while the public regulatory agency essentially makes non-decisions. (PTO)

132

NRC Finally Proposes a Decommissioning Regulation

Public Utilities Fortnightly 114(10):40-44 (1984, November 8)

A proposed Nuclear Regulatory Commission (NRC) rule deals with the issues of decommissioning methods, timing, planning, financial assurance, environmental review requirements, and acceptable levels of residual radioactivity. The Atomic Industrial Forum (AIF) urged NRC to reduce the paperwork and to allow more flexibility on the method of decommissioning. The new rule introduces an environmental assessment supplement on decommissioning to be submitted at the operating license stage. Plans on funding methods for decommissioning are required as part of the regulations, but not as a license condition. The author reviews AIF arguments and NRC responses as the rule evolved. There will be a 90-day comment period following publication in the Federal Register. The approaching retirement of several facilities will put pressure on the NRC to act on a final rule.

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Rantanen, J., and H. Haerkoenen, Voimayhtioeiden Ydinjaetetoimikunta, Helsinki, Finland

Decommissioning of Olkiluoto Power Plant

YJT-82-52; 31 pp. (1982, December)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DESIGN, PLANNING, AND REGULATIONS

A conceptual plan for decommissioning of Olkiluoto Power Plant is presented. Deferred dismantlement after a safe storage period of 30 years is regarded as the main alternative. The sequence of decommissioning tasks and the techniques for performing them are described, including the management and disposal of decommissioning wastes. Occupational and public radiation dose estimates are given. Manpower requirements and costs of decommissioning are evaluated.

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Regan, J.D., A.A. Paton, P.S. Avanzini, and H. Schwarz, National Nuclear Corporation Limited, Knutsford, Cheshire, United Kingdom; Taylor Woodrow Construction Limited, Southall, Middlesex, United Kingdom; Nucleare Italiana Reattori Avanzati, Genova, Italy; Technische Hochschule Darmstadt, Darmstadt, Federal Republic of Germany;

Review of Plant Design Features Facilitating Decommissioning

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 402-414) (1984)

At the design stage it is necessary to define the decommissioning strategy. This offers the opportunity to influence the design and hopefully deduce the optimum dismantling sequence in terms of cost, dose rate, and time. The decommissioning activity will be some 50 to 150 years in the future, though the strategy must be based on present known or developing technology. Therefore, the developments in remote handling techniques must mean the assumptions are pessimistic. Throughout the paper delayed decommissioning is assumed, though a major accident or pressure for early re-use of the site could require earlier decommissioning. This aspect is not considered in the paper, nevertheless, the conclusions would not be invalidated by such a requirement. A schedule of design features which facilitate decommissioning and details of some specific items installed to aid decommissioning of Advanced Gas Cooled Reactors is presented. The problems of long term storage of decommissioning documents and the selection of material for storage can be influenced at the design stage. Some suggestions regarding storage and eventual recovery of information to aid decommissioning are included. (Auth)

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Reinhart, C.G., Battelie Columbus Laboratories, Columbus, OH

Preliminary Environmental Implications of Alternatives for Decommissioning and Future Use of the Western New York Nuclear Services Center

BMI-X-698 (Rev.); 254 pp. (1979, February)

This study describes in considerable detail the Western New York Nuclear Services Center (WNYNSC) site, the several facilities at the site and the pertinent features of the surrounding area. The geography, hydrology, geology, soils, seismology, meteorology, ecology, agriculture and population of the area and site are presented. The physical characteristics and present status of the nuclear fuel reprocessing facility, the high-level liquid wastes and tanks, and the waste burial areas are described with emphasis on features which are important to the safety of the site in the present and near-term, on features which affect the safety or expense of decontamination and decommissioning and on features which are important to future uses of the site. The current environmental trends at the WNYNSC are reviewed including a description of the continuing program of site monitoring. Five decommissioning alternatives: layaway, protective storage, dismantlement, deferred dismantlement, and entombment, and several possible future uses for the reprocessing plant are described and discussed. Six alternative plans for management of the high-level liquid wastes (HLLW) and three alternatives for disposing of the HLLW tanks are presented as being technically feasible but differing in effort required and risk to the public remaining after disposal. Several options are described for decommissioning or continued use of the two waste burial areas. These range from complete exhumation, repackaging and removal of the wastes to another site, to reopening for commercial waste disposal.

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Robbins, T.R., and J.M. Vallance, Pickard Lowe and Garrick, Washington, DC

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DESIGN, PLANNING, AND REGULATIONS

A New Approach to the Costs of Decommissioning Nuclear Power Plants

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 92-93); Transactions of the American Nuclear Society 45:92-93 (1983)

The costs associated with decommissioning a nuclear power plant following expiration of its operating license are well recognized within the industry; but there are other significant costs associated with operation termination. The authors examine the extraordinary nuclear fuel revenue requirements which are inherent in the termination. This increase in revenue requirements, which occurs over the last few cycles of plant operation, is due to the fact that it remains necessary to load sufficient fissile material each cycle to achieve the specified cycle energy production; however, the fuel loaded in these cycles will achieve a much lower burnup than would be achieved in an ongoing equilibrium fuel cycle. The result is a substantial increase in the fuel revenue requirements for the last few cycles of plant operation.

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Seghers, F.

The Tax Status of Decommissioning Funds "May Be Revisited"

Nucleonics Week 25(25):6 (1984, June 21)

A joint House-Senate conference on the FY-85 deficit reduction package may reexamine the tax status of decommissioning funds. The committee has already approved a provision to allow utilities to take a deduction for decommissioning expenses at the time payment is made into a segregated decommissioning fund, rather than at the time of actual decommissioning. (Auth)

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Silver, R.

Utilities Fear that Financing Is Greatest Decommissioning Hurdle

Nucleonics Week 25(42):12-13 (1984, October 18)

U.S. utility financial officers say that the technical side of decommissioning nuclear plants after 30 to 40 years of service will be "no big deal." They are uncertain just how regulatory changes will impact on current cost estimates. The Nuclear Waste Policy Act of 1982 and federal provisions for regional multi-state, low-level waste disposal sites have them worried. (Auth)

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Silver, R.

Whiteshell Research Reactor WR-1 Will Be Permanently Shut Down

Nucleonics Week 26(18):13 (1985, May 2)

Atomic Energy of Canada Limited (AECL) has announced that the Whiteshell research reactor, WR-1, will be permanently shut down "in a matter of weeks." WR-1 is a 60-MW(t) organic-cooled unit designed to test a range of nuclear fuels with a heavy-water moderator. WR-1 was completed at AECL's Whiteshell research facility, about 60 miles northeast of Winnipeg, in 1965 at a cost of $14.5-million (Canadian). WR-1 has supplied heating to research facilities to save about $5.5-million in heating oil during the past half dozen years. Cooled by an organic mix of hydrocarbons (hydrogen-treated terphenyls), the reactor had one section operating with an outlet temperature of 400 degrees C for seven years. During two decades of operation, WR-1 allowed AECL to test a wide range of fuels, fuel channels, and reactor materials. The reactor is being shut down as part of AECL's overall cost-cutting. Reactor research at Whiteshell will now concentrate on development of AECL's Slowpoke-3 concept for a compact heat-energy facility. (Complete Text)

140
Snyder, B.J., U.S. Nuclear Regulatory Commission, Washington, DC

Regulatory Perspective on the Cleanup of TMI-2

Transactions of the American Nuclear Society 43:2-3; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 2-3) (1982)

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In response to the regulatory demands being placed on the plant owner, the U.S. Nuclear Regulatory Commission established a special contingent within the Office of Nuclear Reactor Regulation, the TMI Program Office. The sole function of this office is to provide regulatory oversight of the licensee's cleanup activities. This office consists of NRC headquarters and TMI site locations staffed with both licensing and inspection and enforcement personnel. All major cleanup activities involving radioactive materials require NRC approval, including approval of all detailed procedures. This requirement has been made a part of licensee's technical specifications for TMI-2, in recognition of the unique character of the activities.

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Stang, R., W. Steinkilberg, and W. Zimmermann, Kraftwerk Union AG, Erlangen, Federal Republic of Germany

Prototype Decommissioning of Nuclear Plants - Plans To Remove the FR2 Reactor Block

CONF-830636; Jahrestagung Kerntechnik '83 (Nuclear Technology '83), Proceedings of a Conference, Berlin, Federal Republic of Germany, June 14-16, 1983; (pp. 804-807) (1983)

The oldest German reactor, the FR2 at Karlsruhe, was brought out of operation after 20 years at the end of 1981. Studies of the feasibility of complete removal of the installation and adaptation of the reactor building for other purposes are presented. (ARE)

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Stucker, J.P., Rand Corporation, Santa Monica, CA

Costs of Closing Nuclear Power Plants

Progress in Nuclear Energy 14(2):137-163 (1984)

Methods for estimating the full costs of closing nuclear power plants are presented. The paper (1) reviews recent studies of the economic costs of closing the Indian Point and Zion nuclear generating facilities, (2) offers methods for synthesizing the total cost of such closures, and (3) identifies and discusses the uncertainties associated with the major cost drivers. Scenarios describing the distribution of the costs among ratepayers, stockholders, bondholders and taxpayers are then used to illustrate alternative viewpoints on net and total closure costs. A matrix framework for conceptualizing and displaying closure costs is developed and used to illustrate the inadequacies of the cost estimates developed for recent public-policy debates.

143

Swanson, V.A., Rockwell International Corporation, Pasadena, CA

SNAP Environmental Test Facility (Bldg 024) Deactivation Safeguards Analysis Report

SAR-652-240-006; DOE/SF/00701-T55; 15 pp. (1973, January 11)

The SNAP Environmental Test Facility, Building 024, will be deactivated. This report describes the facility to be deactivated, the methods to be used, and the hazards involved. The procedure and precautions to be used in deactivation process are described.

144

Thomas, C.O., U.S. Nuclear Regulatory Commission, Washington, DC

Proposed Issuance of Orders Authorizing Disposition of Component Parts and Terminating Facility License - Georgia Institute of Technology

Federal Register 49(226):45939-45940; DOCKET 50-276 (1984, November 21)

The U.S. Nuclear Regulatory Commission is considering issuance of Orders authorizing the Georgia Institute of Technology to dismantle and dispose of the component parts of the AGN 201 research and training reactor in their possession, and terminating Facility Operating License No. R-111 in accordance with the licensee's application dated September 26, 1984. (JWF)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DESIGN, PLANNING, AND REGULATIONS

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U.S. Nuclear Regulatory Commission, Washington, DC

Pacific Gas and Electric Company - Availability of Licensee's Environmental Report and Notice of Intent by the NRC To Prepare an Environmental Impact Statement

Federal Register 49(213):44039; DOCKET 50-133 (1984, November 1)

Pacific Gas and Electric Company, 77 Beale Street, San Francisco, California 94106 (licensee), is the holder of Operating License No.DPR-7 for the Humboldt Bay Power Plant, Unit No. 3 (the facility) located in Humboldt County, California. Pursuant to the National Environmental Policy Act of 1969 and regulations of the Commission in 10 CFR Part 51, the licensee has filed an environmental report, dated July 30, 1984, in support of an application to decommission the facility and extend License No. DPR-7 to November 9, 2015. After the environmental impacts of the proposed action have been analyzed by the Office of Nuclear Reactor Regulation staff with consideration given to public comments, a draft environmental statement will be prepared for public availability. (JWF)

146

U.S. Nuclear Regulatory Commission, Washington, DC

Decommissioning Criteria for Nuclear Facilities: Extension of Comment Period

Federal Register 50(104):23025-23026 (1985, May 30)

On February 11, 1985, (50 FR 5600), the U.S. Nuclear Regulatory Commission published for public comment a proposed rule setting forth technical and financial criteria for decommissioning licensed facilities. The U.S. Department of the Army, the Department of Energy of the State of Oregon, and other interested parties have requested an extension of the comment period in order to fully evaluate the issues raised and develop comments on the proposed rule. The NRC has decided to extend the comment period for an additional 60 days to July 12, 1985. (JWF)

147

U.S. Nuclear Regulatory Commission, Washington, DC

The University of Texas: Proposed Issuance of Orders Authorizing Disposition of Component Parts and Termination Facilities License

Federal Register 50(105):23207-23208 (1985, May 31)

The U.S. Nuclear Regulatory Commission is considering issuance of orders authorizing the University of Texas (licensee) to dispose of the component parts of the research reactor in their possession, in accordance with the licensee's application dated May 3, 1985, and terminating the Facility Operating License No. R-92. The licensee's application is available for public inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, DC. (JWF)

148

U.S. Nuclear Regulatory Commission, Washington, DC

Northrop Corporation: Finding of No Significant Environmental Impact Regarding Proposed Order Authorizing Dismantling of the Reactor and Disposition of Component Parts

Federal Register 50(177):25351-25352; DOCKET 50-187 (1985, June 18)

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of an order authorizing the Northrop Corporation to dismantle their TRIGA reactor facility in Hawthorne, Los Angeles County, California and to dispose of the reactor components in accordance with the application dated January 14, 1985, as supplemented. The order would authorize dismantling of the facility and disposal of the components in accordance with the licensee's application for decontamination and dismantling dated January 14, 1985, as supplemented. The Commission has determined not to prepare an Environmental Impact Statement for the proposed action. The Commission has prepared an Environmental Assessment of this action, dated May 28, 1985, and has concluded that the proposed action will not have a significant effect on the quality of human environment. (Auth)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DESIGN, PLANNING, AND REGULATIONS

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U.S. Nuclear Regulatory Commission, Washington, DC

Decommissioning Criteria for Nuclear Facilities

Federal Register 50(28):5600-5625 (1985, February 11)

The U.S. Nuclear Regulatory Commission is proposing amendments to its regulations that would set forth technical and financial criteria for decommissioning licensed facilities. The proposed amendments address decommissioning planning needs, timing, funding mechanisms, and environmental review requirements. The intent of the proposed amendments is to assure that decommissioning of all licensed facilities will be accomplished in a safe and timely manner and that adequate licensee funds will be available for this purpose. The proposed rule also contains a response to a petition for rulemaking (PRM-50-22), concerning decommissioning financial assurance, initially filed by the Public Interest Research Group (PIRG), et al. On July 5, 1977. Comments must be received on or before May 13, 1985. (JWF)

150
U.S. Nuclear Regulatory Commission, Washington, DC

Utility Financial Stability and the Availability of Funds for Decommissioning

NUREG/CR-3899 (1984)

The U.S. Nuclear Regulatory Commission is currently developing rulemaking in the area of decommissioning of nuclear facilities. A part of that rulemaking effort is assuring that funds will be available at the time of decommissioning of power reactors. Previous NRC reports have examined this issue by studying various funding methods. This report provides an update by analyzing the relative level of assurance of funding methods, considering the present utility financial situation. In its analysis, the report makes use of specific case situations. The report concludes that the various funding methods studied in the earlier reports including the internal reserve method provide assurance of the availability of funds for decommissioning. (Auth)

151
Wellborn, S.

Nuclear Dilemma: What To Do with Old Plants

Bulletin 106(5444):135-136 (1984, November 24)

Of 86 operating reactors in the U.S., four have shut down permanently and as many as 20 may be shut down by the end of the next decade. Different approaches to the problem and costs of decommissioning are discussed.

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Wieling, N., P.J. Hofmann, R.M. Boothby, and T.M. Williams, Kraftwerk Union AG, Erlangen, Federal Republic of Germany; United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, United Kingdom

Reduction of Exposure to Radiation by Substitution of Co Alloys and Reduction of the Concentrations of Co, Nb and Other Companion Elements in Steel

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 389-401) (1984)

Activation of the alloys used in primary circuits of nuclear reactors increases gamma radiation. This hampers repairs and dismantling operations. The level of radiation can be reduced in two ways: (1) substitution of Co-free alloys for those containing Co, and (2) reduction of the levels of Co and other companion elements responsible for long-lived gamma radiation from steel. The following studies were carried out with European Community support. At KWU, on the basis of earlier KWU studies confirming the resistance of a number of Co-free alloys to friction, abrasion, and corrosion, a study was made of the resistance of such construction materials to erosion, corrosion, and hydro-abrasive wear. At AERE Harwell, a study was made of the sources of gamma radiation from steel. The results showed that the most important source of such radiation over the first 100 years following a final reactor shut-down is Co, but that Nb and Ag subsequently become more important. Investigation of possible ways of reducing the concentrations of these elements led to the conclusion that purer raw materials will have to be used. (Auth)

153

Wood, R.S., U.S. Nuclear Regulatory Commission, Washington, DC

NRC Perspective on Property Insurance and Decommissioning

Nuclear Insurance Issue, Proceedings of an Atomic Industrial Forum Conference, Washington, DC, February 13-16, 1983 (1983)

Recent Nuclear Regulatory Commission (NRC) activities in the nuclear property insurance area are surveyed and the status of NRC generic decommissioning rulemaking is determined. A final interim rule has been published by the NRC requiring commercial reactor licensees to purchase substantial amounts of on-site property damage insurance to be used for decontamination expenses in the event of a nuclear accident. The NRC also plans to issue a rule that will address all aspects of reactor decommissioning, including funding assurance.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING ENVIRONMENTAL STUDIES AND SITE SURVEYS

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Hanulik, J., E. Schenker, and G. Ullrich, Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland

Measurements of Contamination During the Decontamination of the "NS Otto Hahn" Fuel Element Storage Pool

EIR-BERICHT-NR-432; 32 pp. (1981, December)

Sampling and decontamination was carried out by EIR in cooperation with Noell GmbH/Wurzburg. A newly developed instrument for remote electrolytic sampling was used for the first time, and was found useful for initial decontamination measurements, as well as for measurements of residual activities after decontamination experiments and free decontamination. A total of approximately 200 samples obtained by this method were chemically analyzed and measured for nuclide-specific activity. Decontamination experiments on samples from the fuel element storage pool furnished the basis for the subsequent decontamination. For free decontamination, seven treatments were necessary, using about 100-liter decontamination solution/treatment. A total of about 2.5 mCi and 12 kg steel were dissolved, which amounted to a mean removal of a 10 micron layer. Approximately 250 kg of chemicals were used for all decontamination treatments, and about 2,000 liters of liquid waste was formed. EIR and Noell each used 20 man-weeks for combined sampling and decontamination activities; the cumulative dose was 0.5 rem. Nuclide-specific and analytical capability on board proved valuable for rapid information on the progress of decontamination. The technology employed on the NS Otto Hahn probably cannot be directly transferred to other water-cooled reactors without extensive modifications, particularly for more complex systems. (RAF)

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Laurer, G.R., M. Eisenbud, and T. Rahon, New York University Medical Center, Tuxedo, NY

A Gamma-Ray Detection and Imaging System for Remote Decontamination and Decommissioning

Transactions of the American Nuclear Society 46:790; CONF-840614; Proceedings of an American Nuclear Society Annual Meeting, New Orleans, LA, June 3-7, 1984; (p. 790) (1984, June)

The purpose of this work is the design and construction of a remotely operated, scanning radiation detection system to locate, identify, and image high-level sources of gamma-emitting radionuclides in badly contaminated areas such as the Unit 2 reactor building at Three Mile Island (TMI). To achieve successful decontamination of a highly contaminated area, the total radioactive inventory, including identification of specific radionuclides, their quantities, and their locations, must be known. The detection system will provide data for spatial and spectrometric analysis, and will be able to be set up quickly and manipulated remotely to keep exposures low. (Auth)

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Robertson, D.E., K.H. Abel, C.W. Thomas, E.A. Lepel, V.W. Thomas, L.C. Carrick, M.W. Leale, W. Manford, and J.C. Evans, Pacific Northwest Laboratory, Richland, WA

Residual Radionuclide Contamination Within and Around Nuclear Power Plants: Origin, Distribution, Inventory and Decommissioning Assessment

Radioactive Waste Management and the Nuclear Fuel Cycle 5(4):285-310 (1984)

The residual radionuclide concentrations, distributions, and inventories at seven nuclear power plants were investigated to provide a data base for use in formulating policies, strategies, and guidelines for the eventual decommissioning of retired nuclear power plants. Emphasis was placed on measuring the long-lived radioisotopes which are of special concern from a low-level waste management standpoint. These radioisotopes include Co-60, Ni-59, Ni-63, Sr-90, Nb-94, Tc-99, I-129, Cs-137, and alpha-emitting transuranic radioisotopes with half-lives greater than five years. For times ranging from about 10 to 20 years after reactor shutdown, the most abundant long-lived radioisotopes associated with contaminated piping, hardware, and concrete generally include Co-60, Fe-55, Ni-63, and Cs-137. Co-60 and Cs-137 are the main contributors to the external whole body dose for several decades following shutdown. Co-58, Mn-54, and Zn-65 are abundant short-lived radioisotopes at the time of shutdown. Contamination residues normally contained very low concentrations of Sr-90, Nb-94, Pu, Am, and Cm. I-129 and Tc-99, being very soluble long-lived radioisotopes, were generally not associated with residual radioactive contamination to

CHAPTER 2. N ᴗCLEAR FACILiTIES DECOMMISSIONING ENVIRONMENTAL STUDIES AND SITE SURVEYS

any significant degree. Essentially, all of the contaminated piping and hardware (excluding the pressure vessel internals) and concrete within the nuclear power plants can be disposed of as Class A waste, the least restrictive waste category specified in 10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Wastes.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING HEALTH, SAFETY, AND BIOMEDICAL STUDIES

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Bergman, C., and R. Boge, National Institute of Radiation Protection, Stockholm, Sweden

Collective Doses from Recycling of Contaminated Scrap Metal

SSI-RAPPORT-85-04; 8 pp. (1985, January 22)

During maintenance work, nuclear power plants generate large quantities of slightly contaminated scrap metal. The largest volume of this contaminated material is produced in connection with the decommissioning of the plants. Large quantities of metal that are not contaminated at all are also classified as radioactive material because they have been inside controlled areas. All such material is normally regarded as radioactive until measurements or other evidence have shown that the material is free from contamination. Such measurements are often very expensive. The scrap metal represents an appreciable economic value if it can be reused. Collective doses were calculated for the recycling of 90 tons of contaminated scrap metal from a nuclear power plant. The contamination level was of the order of 100 Bq/kg and the resulting collective doses from handling, transportation and melting was calculated to be 7.0 X 10(E-5) man-Sv. The doses from the use of the products manufactured from this batch were negligible although they were not calculated. This report shows that it should be possible to recirculate material with even a higher activity concentration if special precautions are taken, e.g. controlling the activity concentration in the metal and slag fraction, restricting the first stage of recycling and taking care of the slag which might have a higher activity concentration. (Auth)(CAC)

158

Braker, C.J., T.R. Crites, and D.D. Hornbacher, Rockwell International, Energy Systems Group, Rocky Flats Plant, Golden, CO

Administrative Practices To Limit Dose in Environmental Cleanup Operations Involving Plutonium

Dose Limitation System in the Nuclear Fuel Cycle and in Radiation Protection, Proceedings of the International Symposium, Madrid, Spain, October 19-23, 1981; (pp. 499-509) (1982)

The Rocky Flats Plant is a U.S. federal government-owned, contractor-operated facility utilizing plutonium, uranium, beryllium, and other metals to fabricate nuclear components. During the history of plant operations, radioactivity reached the environment. Air, water, and soil concentrations as well as worker and general population doses were within guide values of ICRP 2 recommendations. The advent of ALARA in 1983 and further development of dose limitation concepts necessitated reevaluation of contaminated areas. Documentation of past releases and a radiometric survey of the plant site identified areas where environmental cleanup could be beneficial. Stringent, but achievable, criteria were developed for cleanup activities. Action limits far below existing legal limitations were defined based on background measurements and plant operating experience. Exposure and emission data were periodically reported. No measurable exposures resulted to workers involved in the cleanup efforts. Monitoring stations showed a decline in activity following cleanup efforts. (ARE)

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Henning, K.D., Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Health Physics Aspects of the Decommissioning of NS "Otto Hahn"

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 577-596) (1983, June 8)

After 10 years of operation the nuclear ship, Otto Hahn, was decommissioned for reuse as a conventional merchant ship. The following health physics aspects are considered: (1) Decommissioning concept; Transport of reactor vessel (and shieldings) to GKSS Research Center, also components and systems container conditioned, (2) Licensing procedure; Some typical specialities of a mobile nuclear facility, (3) Personal Dose, Activity Release, Activities and Nuclear Waste; The collective dose was 30 man rem, the emission of aerosol activity 2 uCi during the entire operation, about 14,000 sq m and 37 tons were to be decontaminated, (4) Radioactivity control and monitoring; 10(E+6) single measurements of activity (mostly via dose rate) were necessary, (5)

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Experiences: Some tanks had to be treated in a special manner, (6) Expenditure; An extrapolation of the costs is not possible. In the meantime Otto Hahn is going to be used as a conventional container ship with a speed of 17 knots.

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Hutz, K.H., and J. Obst, Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Health Physics of the Decommissioning of "NS Otto Hahn" from the Decommissioning Company's Viewpoint

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 597-605) (1983, June 8)

This report includes discussions of: (1) essential differences between backfitting measures in nuclear power plants and in the decommissioning of nuclear facilities, (2) structural and radiological knowledge necessary for successful decommissioning, and (3) necessary precautionary measures needed to minimize aerosol release and radiation exposure. For soft or hard decontamination in nuclear power plants, the decontamination of the secondary plant of the Otto Hahn is used as an example. Experience gained when the Otto Hahn was decommissioned has revealed that the accumulated dose exposure per man-year can be restricted to approximately 15 mSv (1500 mrem). Similar values are also to be expected for the decommissioning of nuclear power plants, even if this should take place 5 to 10 years after shutdown.

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Loeschhorn, U., U. Birkhold, J. Obst, and W. Stasch, Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Health Physics Aspects of the Decommissioning of the Niederaichbach Reactor

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 607-615) (1983, June 8)

The dismantling project for the total removal of the Niederaichbach nuclear power plant required the investigation of all radiological consequences arising from such actions. This included, besides investigations of the aerosol release during the disassembly of reactor components, extensive computation of shielding devices. It is essential to carry out dismantling work with the least possible radiation exposure in accordance with health physics principles (Article 28 of the Radiation Protection Ordinance). Consequently, the shielding devices were designed so that in permanently accessible areas, the dose rate does not exceed 0.5 mrem/h. For large components to be dismantled, radiological dose curves (rate/distance) for handling were established for case-to-case decisions.

162

Werner, M.M., D.K. Myers, and D.P. Morrison, Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada

Follow-Up of CRNL Employees Involved in the NRX Reactor Cleanup

AECL-7760; CONF-8205253; Proceedings of the Third Annual Canadian Radiation Protection Association Meeting, Vancouver, British Columbia, Canada, May 4, 1982; (16 pp.) (1982, July)

Data available to date on the mortality of continuing and retired employees of the Chalk River Nuclear Laboratories are consistent with the "healthy worker" effect that has been observed in similar studies at other nuclear facilities. Because of an accident at the NRX research reactor in December 1952, the reactor was largely dismantled and rebuilt in 1953-54. These operations involved appreciable radiation exposures to a number of employees. The follow-up of the 850 on-site AECL staff involved in the cleanup has indicated that there were no unusual patterns in the mortality of this group when compared with those of the general population of Ontario.

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Zizka, B., Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia

Radiation Safety Aspects of Nuclear Facilities Decommissioning

Radioaktivita a Zivotne Prostredie 5(1):61-64 (1982)

Attention is drawn to certain important radiation safety aspects of the decommissioning of nuclear power plants. The problem area is divided into five main problems: (1) protection of personnel during decommissioning; (2) protection of the population; (3) minimization of hazards for the population until the complete removal of radioactive products in the power plant; (4) the protection of personnel during processing, transport and final disposal of radioactive wastes; and (5) minimization of radiation hazards for the population during transport and deposition of radioactive wastes.

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Zizka, B., Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia

Protection of Personnel and Population in Vicinity During Nuclear Power Plant Dismantling

Radioaktivita a Zivotne Prostredie 6(4):247-253 (1983)

The reasons are given for the dismantling of a nuclear power plant, and three stages of the procedure are described with regard to radiation safety of personnel and the environment. The first stage involves shutting off the nuclear power plant under surveillance with monitoring of radioactivity in the power plant area and in the surrounding area. The second stage involves partial evacuation of the site including the removal of non-contaminated equipment and the decontamination of internal and external parts of buildings and the execution of safety and control measures aimed at precluding health hazards to personnel and population. The third stage involves the evacuation of the whole site consisting of the removal of all radioactive parts of the nuclear power plant and the use of the area for non-nuclear purposes. Techniques and experience gained with the repair and maintenance of nuclear power plants will be used for protecting personnel involved in the removal operations. Protection of the environment from radiation during dismantling must come from the system of environmental control used during the plant's operation.

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Allen, R.P., Pacific Northwest Laboratory, Richland, WA

Nonchemical Decontamination Techniques

Nuclear News 28(8):112-116 (1985, June)

The decontamination techniques summarized in this article represent a variety of surface cleaning methods developed or adapted for component-type and facility-type decontamination applications ranging from small hand tools to reactor cavities and other large surface areas. The following is a list of representative "nonchemical" decontamination techniques: hand scrubbing, ultrasonics, high-pressure water, ultrahigh-pressure water, abrasive cleaning, dry-ice blasting, electrocleaning, immersion electropolishing, in situ electropolishing, alternating electrolysis, acid cleaning, high-pressure Freon cleaning, vibratory finishing, mechanical methods, steam/hot water cleaning, decontamination foams, gels, and pastes, strippable coatings, molten salt methods, and thermal erosion. Decontamination operations may be performed effectively and with significant savings in cost and exposure using techniques well-suited to the particular needs of the plant. The key element is to give sufficient priority to decontamination to maintain a stable, experienced, and well-trained decontamination group that can utilize effectively the full range of available decontamination technology. (JWF)

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Allen, R.P., and R.F. Hazelton, Pacific Northwest Laboratory, Richland, WA

Conversion of Transuranic Waste to Low-Level Waste by Decontamination: A Technical and Economic Evaluation

PNL-5315; 69 pp. (1984, December)

A study was conducted to evaluate the technical and economic feasibility of using in-situ decontamination techniques to convert glove boxes and other large TRU-contaminated components directly into LLW. The results of the technical evaluation indicate that in-situ decontamination of these types of components to non-TRU levels is technically feasible. Applicable decontamination techniques include electropolishing, hand scrubbing, chemical washes/sprays, strippable coatings and Freon spray-cleaning. The removal of contamination from crevices and other holdup areas remains a problem, but may be solved through further advances in decontamination technology. Also, the increase in the allowable maximum TRU level from 10 nCi/g to 100 nCi/g as defined in DOE Order 5820.2 reduces the removal requirement and facilitates measurement of the remaining quantities. The major emphasis of the study is on a cost/benefit evaluation that includes a review and update of previous analyses and evaluations of TRU-waste volume reduction and conversion options. The results of the economic evaluation show, for the assumptions used, that there is a definite cost incentive to size-reduce large components, and that decontamination of sectioned material has become cost competitive with the size reduction options. In-situ decontamination appears to be the lowest cost option when based on routine-type operations conducted by well-trained and properly equipped personnel.

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American Nuclear Society, La Grange Park, IL

Decontamination of Nuclear Facilities, International Joint Topical Meeting ANS-CNA, 1982

CONF-820973; Decontamination of Nuclear Facilities, Proceedings of an International Conference, Niagara Falls, Ontario, Canada, September 19-23, 1982 (1982)

This symposium proceedings contains 42 papers. Volume 1 includes the regulation, control and consequences of decontamination, and decontamination of components and facilities. Volume 2 deals with the chemical methods of decontamination, non-chemical methods of decontamination and laboratory developments, and TMI decontamination experience. Keynote addresses on the subject of decontamination experience and technology, mechanisms of oxide dissolution by acid chelating agents, application and effectiveness of non-chemical decontamination processes,and status report on the TMI-2 cleanup program are reported.

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Arvensen, J., and H.P. Hermansson, Studsvik Energiteknik AB, Nykoeping, Sweden

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Decontamination of Pressurized Water Reactors

PCT International WO 84 03,170 (1984, August, 16) (1984, August 16)

A method for decontaminating the radionuclide-contaminated primary system surfaces of pressurized water reactors is described. The method consists of oxidation of the acid-insoluble corrosion products on the metal surfaces and subsequent dissolution in an acidic decontamination solution. The oxidation is carried out with a water-based oxidizing agent having a pH below 7 and containing permanganate, chromic acid, and ozone, and at relatively low temperature, (e.g. under 60 deg and often below 25 deg). Thus, Inconel 600 from a PWR steam generator was decontaminated using treatment solutions (1) containing acetic acid or nitric acid, potassium permanganate, chromic acid, boric acid, and ozone and (2) boric acid and citric acid.

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Baumann, I., H. Knittel, and H. Stuehler-Kieltyka, Quadrex International GmbH, Mannheim, Federal Republic of Germany

Decommissioning: Electrochemical Decontamination and Polishing

CONF-830636; Jahrestagung Kerntechnik '83 (Nuclear Technology '83), Proceedings of a Conference, Berlin, Federal Republic of Germany, June 14-16, 1983; (pp. 832-833) (1983)

Use of electropolishing techniques in the decontamination of radioactive components of nuclear power plants has been considered as a means of reducing surface radioactivity of parts to values below the tolerance level. This allows expensive materials which would otherwise have been wasted to be recycled. (ARE)

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Bittner, A., D. Jungwirth, M. Bernard, L. Gerland, C. Brambilla, and J. Fitzpatrick, Dyckerhoff and Widmann AG, Munich, Federal Republic of Germany; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France; Agip Nucleare, Medicina, Bologna, Italy; Electrowatt Engineering Services, Limited, Horsham, West Sussex, United Kingdom

Concepts Aimed at Minimizing the Activation and Contamination of Concrete

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 371-388) (1984)

The following two concepts have been investigated as part of the Commission of the European Communities Research and Development for Decommissioning: (1) minimizing the activation of the biological shield, (2) removable coatings to protect concrete surfaces from contamination. The first concept was investigated independently by Dyckerhoff and Widmann AG, Germany and Electrowatt Engineering Services Limited, United Kingdom. Agip Nucleare, Italy and Commissariat a l'Energie Atomique, France independently investigated the second concept. The object of all investigations was to determine if certain measures could be included in the design of the plant such that a reduction in waste arising and personnel exposure at decommissioning could be achieved. To study the feasibility of the first concept, designs for light water reactor plants (both BWR and PWR) were examined. Neutron flux levels were calculated using the ANISN 2. A range of possible neutron absorbing materials was considered and their suitability for the concept determined. During research for the characterization of coatings for the protection of concrete structures, mainly materials generally available on the open market were tested. These tests were in accordance with given standards, guidelines and specifications for contamination, decontamination, adhesion, elasticity, flexibility, mechanical and chemical resistance, easy removal after the action of active media, and artificial aging. (Auth)

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Boulitrop, D., J.P. Gauchon, and Y. Lecoffre, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance, France; Alsthom Atlantique Neyrtec, Grenoble, France

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Specific Decontamination Methods: Water Lance, Erosion by Cavitation, Application of Gel-Based Decontaminants

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 177-195) (1984)

Decontamination methods involving spraying are suitable for use in the decommissioning of nuclear installations because of their compatibility with remote control methods, which make it possible to treat materials on the spot with no irradiation of personnel. They do not give rise to contamination from aerosols but produce a large amount of radioactive waste, and their effectiveness is sometimes limited. The erosive and decontaminating effects of high-pressure water lances have been improved at the CEN-Cadarche by increasing pressure (up to 600 bars) and adding chemical reactants prior to spraying. Alsthom Atlantique Neyrtec at Grenoble has developed a system of erosion by cavitation which can be adapted for decontamination purposes. At the CEN-Saclay a comparative study on the incorporation of decontaminants in gel-based media has made it possible to select compounds which are effective in decontaminating the main materials used in the nuclear industry. (Auth)

172

Bregani, F , R. Pascali, and R. Rizzi, Ente Nazionale per l'Energia Elettrica, Centro Comune di Ricerca, Milan, Italy

Chemical Decontamination for Decommissioning Purposes: Vigorous Decontamination Tests of Steel Samples in a Special Test Loop

EUR-9303; 87 pp. (1984)

The chemical decontamination of metallic surfaces of LWR's, primarily with the use of hard chemical reagents, was studied. The cost of treatment of the resulting radwaste to achieve unrestricted release of the treated components, and the cost of obtaining know-how for in-situ decontamination were taken into account. The decontamination procedures were optimized in static and dynamic tests (DECO-loop). The best values were: for HCl, 4-5 vol-% at low temperature, 0.7-1 vol-% at high temperature (80 deg); for HF + HNO3, 1.5 vol-% HF + 5 vol-% HNO3 at low temperature; 0.3-0.5 vol-% HF + 2.5-5 vol-% HNO3 at high temperature. High flow rates are not necessary, but good recirculation of the solution is needed. The final contamination levels, after the total oxide removal, are in accordance with limits indicated for unrestricted release of materials in some countries. Decontamination of a 10 sq m surface would typically produce 0.5-3.0 kg of dry waste, corresponding to 1.6-10 kg of waste immobilized in concrete. Finally, the preliminary design for vigorous decontamination of the regenerative heat exchanger of the Garigliano plant is reported.

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Capella, J.A., and D.E. Fowler, Health Physics Systems, Inc., Gainesville, FL

Tool Decontamination Method

U.S. Patent 4,443,269 (1984, April 17)

Disclosed is a system and method for cleaning radioactively contaminated articles, including tools and like items of hardware. The system includes a cleaning chamber for receiving and sealing therein the contaminated articles, a high pressure spray gun disposed within the cleaning chamber for spraying the contaminated articles with a clean solvent to dislodge and dissolve the contaminants, and a system for decontaminating the solvent for reuse. The cleaning chamber includes a drain having the capacity to remove contaminated solvent at a rate at least as great as that at which the solvent is sprayed into the chamber, such that substantially no contaminated solvent collects in the cleaning chamber.

174

Card, C.J., J.R. Divine, L.F. Munson, and M.D. Naughton, Pacific Northwest Laboratory, Richland, WA

Chemical Decontamination Methods Applicable to the TMI-2 RCS

Transactions of the American Nuclear Society 43:20; CONF-821103; Proceedings of an American

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DECONTAMINATION STUDIES

Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (p. 20) (1982)

It appears that the Three Mile Island-2 (TMI-2) reactor coolant system (RCS) might have fuel debris and fission products (FD/FP) spread throughout. However, at the present time, there is no commercially available chemical decontamination process recommended for removal of these species. The present program was established to review past work on FD/FP removal, to assess each process for applicability to the general light water reactor post-accident decontamination and to TMI-2 in particular, and to recommend further work needed to bring the process up to commercial standards.

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Childs, E.L., Rockwell International, Energy Systems Group, Rocky Flats Plant, Golden, CO

Decontaminating Metal Surfaces

U.S. Patent Application 6,573,252; 25 pp. (1984, January 23)

Radioactively contaminated surfaces can be electrolytically decontaminated with greatly increased efficiencies by using electrolytes containing higher than heretofore conventional amounts of nitrate, e.g. greater than 600 g/l of $NaNO_3$, or by using nitrate-containing electrolytes which are acidic, e.g. of a pH less than 6.

176

Childs, E.L., and J.R. Winkel, Rockwell International, Energy Systems Group, Rocky Flats Plant, Golden, CO

Electrodecontamination of Glove-Box Materials

Nuclear Technology 63(2):271-285 (1983)

A basic electrolyte planned for use as an electrodecontamination step in the advanced size reduction facility is evaluated. The effects of process variables on metal dissolution rates are investigated, and optimum process conditions are identified. Decontamination to low-level waste standards is achieved through the removal of 2.4 mg/sq cm metal surface. The fastest throughput rates are achieved with solution of pH 7, low temperatures (35 degrees C), and with low-chromium levels in the electrolyte. Electrical efficiencies of the process range from 10 to 20%.

177

Cruickshank, A., Rockwell International, Energy Systems Group, Rocky Flats Plant, Golden, CO

Developing Techniques for Decontamination

Nuclear Engineering International 28(348):41-44 (1983, November)

Babcock Woodall - Duckham (BW-D) of England and Quadrex of the United States are co-operating in the marketing of a wide variety of decontamination techniques which have the potential to clean materials and components ranging in scale from small transducers to complete primary circuits. Lomi (low oxidation-state metal ion) decontamination and the Pod (PWR oxidation decontamination) process for application to PWR scales are described. Two significant joint BW-D/Quadrex projects, the Lomi decontamination of an American PWR steam generator channel head and the Freon cleaning of CEGB equipment, are discussed.

178

De Tassigny, C., I.L. Davies, and G. Brambilla, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Grenoble, France; Taylor Woodrow Construction Limited, Southall, Middlesex, United Kingdom;

Immobilization of Contamination on Metals and Concrete

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 293-313) (1984)

The dismantling of nuclear plants produces large quantities of concrete dust and metal fragments. Suitable coatings are necessary to fix surface contamination and limit diffusion of radionuclides during transport and temporary storage. Three comparative studies have been performed by NUCLECO, CEA, and Taylor Woodrow Construction, Limited. The metal coatings were chosen from a selection of two component polymers, epoxy and elastomeric polyurethane resins. A layer of epoxy resin 150 microns thick will effectively fix the contamination. The polyurethane resins can be projected to a thickness of at least 5 mm, which is necessary to insure sufficient mechanical protection. Weakly active metallic waste resulting from the dismantling of nuclear reactors has been coated in this manner. Sodium silicate combines with the concrete dust to give a compound which is hard and stable. The most effective composition contains a SiO2:Na2O ratio of 285:1 with a binding efficiency from 32% to 35%. The dust is collected in a conveyer system and transformed into pellets. (Auth)

179
Demmitt, T.F., and J.C. De Vine, Jr.

First Experiences with Cleanup Operations at Three Mile Island

Atomwirtschaft, Atomtechnik 29(2):93-99 (1984, February)

Major accomplishments have included: Removal and purification of more than 1,500,000 gallons of contaminated water from the reactor building basement, AFHB, and RCS including extraction and immobilization of about 350,000 ci of radioactivity contained therein; completion of more than half of the required building decontamination work in the AFHB; accomplishment of the majority of the initial gross decontamination work required in the reactor building in all areas except basement areas; achievement of major progress on dose reduction objectives; release of substantial portions of the AFHB for unrestricted access per TMI-2 radiological control specifications; accomplishment of significant portions of the planning and the preparation required to achieve gross decontamination of the reactor building basement and to control recontamination and provide support decontamination for reactor disassembly and defueling. All of this work has been performed with the utmost regard for the safety of the workers involved, and with elaborate planning and preparation to ensure that no additional deleterious consequences result from the damaged TMI-2 reactor.

180
Dietrich, G., H.J. Schartz, W. Hempelman, and W. Stegmaier, Kraftanlagen AG, Heidelberg, Federal Republic of Germany

Decontamination of Metallic Waste from Nuclear Facilities for Unrestricted Release

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 513-517) (1983)

Volume reduction technologies are suitable for application to contaminated equipment generated by nuclear power plant decommissioning activities. Related research in West Germany, aimed at devising reduction approaches specifically for metallic wastes, is surveyed. Volume compacting can be achieved by crushing and subsequent compacting for intermediate or ultimate storage. Another option entails dismantling of the components and subsequent decontamination below the specified limit value which allows their reuse.

181
Divine, J.R., E.M. Woodruff, and L.F. Munson, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

Overview of Decontamination as a Precursor to Decommissioning

NUREG/CP-0048 (Vol. 6); CONF-8310143; Water Reactor Safety Research, S.A. Szawlewicz (ed.), Proceedings of the 11th Nuclear Regulatory Commission Information Meeting, Gaithersburg, MD, October 14, 1983, Vol. 6; (pp. 88-101) (1984, January)

Decontamination of operating reactors has long been a subject of discussion, research, and development. This area continues to be pertinent today because of increasing occupational exposure. The magnitude of radiation fields in operating reactors indicates the need for decontamination as a precursor to decommissioning. In decommissioning a reactor, the operator has several options which may or may not include decontamination. Indeed, decontamination is justified only if one or more of the following criteria are met: (1) the net occupational exposure is less with a decontamination step; (2) the net volume of waste that goes to a radioactive waste site is lower with decontamination; or (3) it is not feasible to put the site in storage for a sufficiently long period to allow the radioactivity to decay to a sufficient degree. Because of the probable need for decontamination, the NRC requested the Pacific Northwest Laboratory to conduct a program to review decontamination as a precursor to decommissioning. The emphasis of the program was to determine its effects on occupational exposure and on waste volume reduction.

182

Ebeling, W., B. Boedeker, and K. Rose, Hauptabeilung Forschung und Entwicklung, Salzgitter, Federal Republic of Germany

Decontamination of Concrete Surfaces by Flame Scarfing

EUR-8969 (1984)

To optimize the flame scarfing parameters, removal experiments were conducted with a flame scarfing burner on inactive coated (e.g. with epoxy resins) and uncoated concrete samples. The deposition of dust and aerosols developing from the flame scarfing is controllable. A total degree of deposition between 99.991 and 99.999% could be reached in a vacuum line with 3 filter units arranged one after the other. Tests on contaminated concrete surfaces could be carried out in the storage of the solid waste of the decommissioned Gundremmingen nuclear power plant KRB-A. The contamination consisted essentially of Cs-137 and Co-60, in which 90% of the activity came from Cs-137. A maximum of four flame scarfings was necessary.

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Ebeling, W., B. Boedeker, K. Rose, and K.H. Schaller, Salzgitter AG, Salzgitter, Federal Republic of Germany; Noell (G.G.) GmbH, Wuertzburg, Federal Republic of Germany; Commission of the European Communities, Brussels, Belgium

Decontamination of Concrete, with Particular Reference to Flame Scarfing

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 161-176) (1984)

When decommissioned nuclear power stations are demolished, the contaminated surface layers must be removed, if it is not intended to diamantle and store the entire structure. The economics of this operation are important because the contaminated areas can be very large. The aim of this report is to give an outline of existing methods of concrete decontamination. Both stripping and non-stripping methods are described, though the latter are relatively unimportant for the purposes of demolition. Particular reference is made to flame scarfing, which has been tested by Salzgitter AG/Noell as part of the Community research program "Decommissioning of Nuclear Power Plants." The effectiveness of flame scarfing as a method of decontaminating concrete has been established by tests at the decommissioned nuclear power plant Gundremmingen KRB-A. (Auth)

184

Eickelpasch, N., and M. Lasch, Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Federal Republic of Germany

Recent Experience with Electro-Chemical Decontamination

VGB Kraftwerkstechnik 64(3):240-243 (1984, March)

Gundremmingen nuclear power station, Unit A, a 250 MW boiling water reactor, was finally shut down in 1977 after an operating life of more than 10 years. In the context of the subsequent shut-down strategy different decontamination procedures were tested on the contaminated pipework sections from the power station. An electro-chemical decontamination procedure proved to be extremely effective and economic. This involved the immersion of the steel or iron sections to be decontaminated in an electrolytic solution and their connection to the positive pole of a direct current source. A second electrode is connected in the solution as the cathode. With suitable electrolytes with high dispersability and high current density the surface of the material can be cleaned in strengths from 10 to 200 microns including the contaminated oxide coatings adhering to it.

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Erion, T., and J. Morgan, University of Florida, Center for Intelligent Machines and Robotics, Gainesville, FL

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DECONTAMINATION STUDIES

Major and Minor Reactor Servicing and Decommissioning

DOE/ER-10089-2; CONF-810337; Workshop to Delineate the Economic and Policy Issues for Remote Maintenance in Energy Systems, Proceedings of a Conference, Gainesville, FL, March 9, 1981; (pp. 193-219) (1981)

Robotic manipulator systems for reactor decommissioning are covered. Development programs at Westinghouse and General Electric Company are discussed. (GHT)

186

Furutani, Y., T. Hasegawa, A. Minato, F. Kawamura, and H. Ito, Hitachi Limited, Tokyo, Japan

Method of Decontaminating Metal Material Contaminated with Radioactivity

Japanese Patent 57,76,500/A/ (1982, May 13)

A technique was developed to reduce the quantity of radioactive waste produced by decontamination processes without decreasing the decontaminating efficiency of conventional electrolytic polishing methods. An electrolytic tank is filled with an aqueous sodium chloride electrolyte solution. Metal treating material is adhered to the side of the tank. A pair of electrodes are dipped in the solution, and an electric current is applied. The metal treating material serves as an anode. Part of the electrolyte is continuously removed by pump and the sludge containing contaminated material and metal treating material hydroxide are isolated via a filter. After heavy metal ions are selectively adsorbed to activated charcoal. oxime is added to the filtrate and is then returned to the tank to be reused. (PTO)

187

Gardner, H.R., R.P. Allen, L.M. Polentz, W.E. Skiens, G.A. Wolf, and L.R. Anderson, Quadrex Corporation, Richland, WA

Evaluation of Nonchemical Decontamination Techniques for TMI-2 RCS Application

Transactions of the American Nuclear Society 43:20-21; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 20-21) (1982)

A wide variety of techniques that can be utilized for the decontamination of radioactively contaminated surfaces are available to meet the needs of nuclear facilities. The purpose of this work is to describe, characterize, and evaluate techniques that appear to have potential for decontamination and/or the removal of fuel debris and corrosion products from the Three Mile Island-2 Reactor coolant system and its components. The techniques selected for evaluation include those with only on-system capability, those with only off-system cability, and those with both on- and off-system capability. Excluded from consideration are the traditional or common chemical decontamination techniques.

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Gauchon, J.P., F. Bregani, W. Ahlfanger, and M. Lasch, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance, France; Ente Nazionale per l'Energia Elettrica, Centro Comune di Ricerca, Milan, Italy; Kernkraftwerk Lingen GmbH, Lingen, Federal Republic of Germany; Kernkraftwerk Gundremmingen Betriebsgesellschaft GmbH, Gundremmingen, Federal Republic of Germany

Composition of Contamination Layers

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 115-138) (1984)

Some of the earliest of decontamination methods concerned the removal of the oxide layers. This paper presents the research carried out in several European countries, on thickness, distribution, and characterization of the contaminated layers and penetration depth of each radionuclide. Studies were conducted at KWL on the composition of contamination layers. These investigations were performed on samples taken out of the primary circuit of the Lingen reactor [250 MW(e) BWR shut down in 1977 after nine years of operation]. Activity depth profiles and characteristics of the oxide layers have been determined on the pipe samples: (1) after removal of 86 microns by electrolytic erosion in the primary water pipe samples, the Co-60 content is equal to the content of the outer part of the pipe, (2) the same result is achieved after removal of about 80-90 microns on the condensate pipe. ENEL-CRTN, Milan, developed vigorous decontamination techniques using contaminated samples from the Garigliano reactor (160 MW BWR shut down in 1978 after 15 years of operation). A characterization of the oxide layers showed the presence of magnetite, nickel ferrite, and copper oxide. Radionuclide measurement on some specimens of various primary tubing showed surface contamination of about 10(E+7) nCi/sq m of gamma activity mainly due to Co-60 and about 10(E+4) nCi/sq m due to alpha activity. KRB, Gundremmingen, studied the development of economic decontamination in the KRB-A nuclear power plant [a 237 MW(e) BWR shut down in 1977 after 11 years of operation]. Even in special areas of very high contamination and frequent damages of the protective paint during plant operation, the penetration did not exceed 7 mm. CEA/CEN, Cadarche performed studies on metal decontamination by chemical methods. Several experiments have been made with contaminated oxide from electromagnetic filter connected to the primary circuit of the PWR. The best result is obtained with a fluonitric bath after pre-treatment. The tests mentioned have been carried out on samples from the German BWR ISAR. The specimens have been taken of a non-activated ferritic steel component which had been operating for 5 years in the primary cooling circuit. Among the reagents which are available for decontamination, sulfuric acid, halogenous and formic acid were chosen. An electrolytic decontamination in two steps (reduction followed by oxidation) is used. (Auth)

189

Gomer, C.R., M. Sappok, M. Allibert, and F. Delabbaye, British Steel Corporation, Sheffield Laboratories, Moorgate, Rotterham, United Kingdom; Siempelkamp Giesserei GmbH and Company, Krefeld, Federal Republic of Germany; Institute Nationale Polytechnique de Grenoble, St. Martin d'Heres, France; Seri Renault Ingenierie, Bois d'Arcy, France

Treatment of Metal Waste by Melting

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 314-326) (1984)

Possibilities in melting are listed under four operation types. Work done by BSC is essentially of the reclamation of metal type. That by Siempelkamp is largely aimed at waste conditioning under the volume reduction heading, and for Seri, the aim was waste conditioning by separation of radioactives. At BSC, steel components removed from several kinds of reactors and designated as waste, have been melted and the metal reclaimed. This was in ordinary furnaces and was done without radiological hazards. At Seri the possibilities for cobalt removal from stainless steel were examined. Electroslag refining was seen as a promising process but no slag was found to take cobalt sufficiently into solution for worthwhile separation. Another study was on retention of cobalt in the metal phase in controlled oxidation of stainless steel. Too much cobalt was included in the oxidation product for worthwhile separation. At Siempelkamp work is being done on the design and testing of a small furnace system for enclosed melting and ingot casting from radioactive steel waste. The main purpose is to achieve high volume reduction for most efficient storage/disposal of high radioactive waste. The system enclosure and filtration have shown promise. (Auth)

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Hanulik, J., Gesellschaft zur Foerderung der Forschung an der Eidgenoessischen Technischen Hochschule, Zurich, Switzerland

A Process for the Decontamination of Steel Surfaces and Disposal of Radioactive Waste

U.S. Patent Application 412,375/82; Swiss Patent Application 5611/81; 22 pp. (1982)

A solution is provided for decontaminating steel surfaces, especially in nuclear reactor cooler circuits. The solution contains formic acid and/or acetic acid and at least one reducing agent such as formaldehyde and/or acetaldehyde. The solution is effective to dissolve the iron oxide from the contaminated steel surface directly and/or reductively and to convert it to Fe-(II)-formate or acetate which are stabilized by the reducing conditions in the solution. For waste disposal the dissolved iron is precipitated from the used decontaminating solution, wherein the iron compounds that have been formed are the sole adsorbents for the radioactive materials contained in the decontaminating solution. (Auth)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DECONTAMINATION STUDIES

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Herrmann, G., W. Hoffmann, and H. Wiese, Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Decontamination of Cell 1 at the WAK

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 267-279) (1983, June 8)

On May 17, 1980, radioactivity was detected in the heating circuit of the WAK's dissolver. Investigations showed a slight leakage about the heating jacket allowing 1.9 Ci to escape. The dissolver needed replacing, because repairing was impossible. Before entering the cell, it needed decontaminating. The radiation level had to be reduced to 20-30 mR/hr. Decontamination took place in 4 stages: interior decontamination of containers and piping by purging with solvents, remote-control dismantling and disintegration of installations and containers in the cell and removal from the cell, remote control decontamination of the cell, and direct decontamination of the emptied cell.

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Laser, M., F. Rosenbaum, and W. Schulz, Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Decontamination and Disposal of Dismantled Reactor Components

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 617-624) (1983, June 8)

Dismantled reactor components that cannot be reutilized safely must, according to law, be disposed of as radioactive waste. Satisfactory decontamination may be technically impossible, economically impractical, or may involve undesirable exposure to personnel during the decontamination work itself. Decisions for either utilization or waste disposal must be made after careful consideration of the materials in question. Activated dismantled components can not usually be utilized safely. They must, therefore, be disposed of as radioactive waste upon appropriate conditioning, if required. With low-contamination components, e.g. fuel element storage racks, components of the secondary loop of a PWR-type reactor, decontamination is not usually to be excluded owing to radiation exposure of the personnel. Optimization, therefore, will suit economic convenience. For strongly contaminated components having a surface dose rate of up to 10 R/hr, it has proved appropriate to predecontaminate large parts weighing up to 5 tons in chemical cleaning basins. This usually effects a reduction of dose rates down to less than 100 mR/hr. Then, dismantling (mechanical or thermal) into convenient-size parts is possible without remote handling. Further decontamination may follow.

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Loercher, G., A.M. Chapuis, and J. Essmann, NIS Nuklear-Ingenieur-Service GmbH, Frankfurt, Federal Republic of Germany; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, France; Preussen Elektrazitats-Aktiengesellschaft, Hannover, Federal Republic of Germany

Factors To Be Considered in Deciding Whether To Decontaminate for Unrestricted Use

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 196-208) (1984)

In the event of the total dismantling of a nuclear power station, a decision has to be reached as to whether large masses of material should and/or can be decontaminated to such a degree that they can subsequently be recycled or taken to a public refuse dump without being subject to radiological protection regulations. Technical, legal, and economic aspects must be taken into account in such a decision. The estimated costs for the final storage of radioactive waste range from DM 4,000 to DM 6,200 per Mg of net mass, depending on the type of final storage.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DECONTAMINATION STUDIES

In the Federal Republic of Germany, 50 Mg of steel scrap and 30 Mg of brass have already been decontaminated and melted down as part of the re-equipping of the Wurgassen nuclear power station. (Auth)

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McCoy, M.W., H.R. Gardner, and H.E. Wagner, Quadrex Corporation, Richland, WA

Decontamination of Uranium-Contaminated Solid Waste to Releasable Levels

Transactions of the American Nuclear Society 43:127; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (p. 127) (1982)

The objective of the program presented in this paper was to obtain data that will permit evaluation of the vibratory finishing process for decontamination of uranium-contaminated solid waste to a target releasable level of 8.33 Bq/100 sq cm.

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McDougall, F., Bechtel Power Corporation, Middletown, PA

TMI-2 Containment Decontamination Plans

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. N1 - N10) (1980, October)

Because of other priorities such as containment entry and the purge program and engineering for recovery facilities, containment decontamination is only in the preliminary planning stages; however, a planning study was completed. That study is summarized with emphasis on remote decontamination techniques. The objectives are to reduce the likelihood of significant personnel contamination and to reduce the general radiation levels in the containment to allow longer personnel stay-times. (ARE)

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McGuire, P.J., Boston Edison Company, Plymouth, MA

Nuclear Reactor Vessel Decontamination Systems

U.S. Patent 4,496,519 (1985, January 29)

A decontamination system is described for reactor vessels. The system comprises an assembly which is introduced into the vertical cylindrical vessel of a typical BWR through the open top. The system is operable without entry by personnel into the contaminated vessel prior to the decontamination operation. The assembly includes a circular track which is centered by guide-ways permanently installed in the reactor vessel. The track guides opposed pairs of nozzles through which water under very high pressure is directed at the wall. As the nozzles are driven around the track in close proximity to the vessel wall, the water jets progressively cut and sweep away a tenacious radioactive coating. The whole assembly is hoisted to a level above the top of the vessel by a crane, and outboard slides on the assembly are engaged with the permanent guide-ways. The assembly is then progressively lowered in the vessel as the decontamination operation continues. The assembly also includes a low pressure nozzle which forms a spray umbrella above the high pressure nozzles to contain radioactive particles dislodged during the decontamination.

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Nievelstein, M., Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Experience Gained with the Decontamination of the Inside of Hot Cells

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 243-253) (1983, June 8)

For extensive construction work inside of hot cells, intensive decontamination has to be carried out in order to keep the risk for personnel due to irradiation and difficult working conditions (for instance breathing in protective suits) while working in a cave as low as possible. This is necessary especially if, after long periods of hot operation, the installations of caves have to be repaired or exchanged. An example of such work in the Juelich Hot Laboratory shows that decontamination close to zero-radiation levels can be achieved for decommissioning.

198

Ochiai, A., K. Nagura, and T. Noura, Kobe Steel Limited, Kobe, Japan

Treatment of Radioactive Metallic Waste by the Electro-Slag Melting Method

Conditioning of Radioactive Wastes for Storage and Disposal, Proceedings of an International Symposium, Utrecht, Netherlands, June 21-25, 1982; (pp. 177-190) (1983)

The applicability of the electro-slag melting method for treating plutonium-contaminated metallic waste was studied. A 100 kg test furnace was built, and simulated metallic waste was melted and solidified in this furnace. Waste volume was reduced to 1/25 with a decontamination factor of 25. The slag and the copper are reusable. The process is expected to be employed in the Plutonium Contaminated Waste Treatment Facilities.

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Ortmayer, R.M., and P. Finke, NTG Nukleartechnik GmbH und Partner, Federal Republic of Germany

Decontaminating the Internal Surfaces of a Reactor Vessel

European Patent Application EP 116663 A1 (1984, August 29)

A procedure is described for decontaminating the inner surfaces of a reactor vessel by removing the usual two-layer oxide deposits. This task is accomplished by forming a fluid jet from a medium in the gaseous or liquid state. The jet, which has a pressure equal to or less than 400 MPa and a speed 0.6-3.5 times the speed of sound, is directed by means of a nozzle at the wall to be cleaned. The oxide deposits consist primarily of Fe, Cr, Ni, and the fission products Co-60, Zr-95, and Ce-144. These fission products contribute to a mean dose rate of approximately 240 R/hr. (PTO)

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Pascali, R., F. Bregani, W. Ahlfanger, M. Lasch, and J.P. Gauchon, Ente Nazionale per l'Energia Elettrica, Centro Comune di Ricerca, Milan, Italy; Kernkraftwerk Lingen GmbH, Lingen, Federal Republic of Germany; Kernkraftwerk Gundremmingen Betriebsgesellschaft GmbH, Gundremmingen, Federal Republic of Germany; Commissariat a l'Energie Atomique, Centre de Marcoule, Bagnols-sur-Ceze, France

Chemical and Electrochemical Decontamination

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 139-160) (1984)

Among operative decommissioning problems, the decontamination procedures, by chemical and electrochemical methods, of contaminated metallic surfaces of nuclear power plants has been studied. The aim of these researches is to develop vigorous decontamination techniques, taking into account the cost of waste treatment, to possibly achieve unrestricted release of decontaminated materials, and to obtain know-how for in-situ applications. Four research projects are specifically reported. Studies on the composition of contamination layers and on the efficiency and mechanism of decontamination procedures were performed by KW Lingen. Vigorous decontamination tests of steel samples coming from the BWR Garigliano plant were carried out by ENEL-CRTN Milan. The development of economic decontamination procedures, in particular electrochemical decontamination, was studied by KRB Gundremmingen. Tests on metal decontamination by chemical and electrochemical methods was performed by CEA-CEN Cadarche. (Auth)

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Regan, J.D., S.J. Cripps, B.R. Kelly, B. Hambelton, and J.R. Nicholson, National Nuclear Corporation Limited, Risley, United Kingdom

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Design Features Facilitating the Decommissioning of Advanced Gas-Cooled Reactors

EUR-9207; 51 pp. (1984)

The design of the AGR is discussed as in the proposed decommissioning plan for delayed decommissioning. The special features which assist in decommissioning are presented. As a result of the study a catalog of design features facilitating decommissioning was prepared. In addition, calculations for radioactive inventories for 10 and 100 years after shutdown were performed. From these calculations a provisional operator dose from activities associated with decommissioning was assessed.

202

Rippin, D.W.T., J. Hanulik, E. Schenker, and G. Ullrich, Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland

Evaluation of a Decontamination Model

EIR-BERICHT-NR-421; 14 pp. (1981, February)

In the scale-up of a laboratory decontamination process difficulties arise due to the limited understanding of the mechanisms controlling the process. This paper contains some initial proposals which may contribute to the quantitative understanding of the chemical and physical factors which influence decontamination operations. General features required in a mathematical model to describe a fluid-solid reaction are discussed, and initial work is presented with a simple model which has had some success in describing the observed laboratory behavior. (Auth)(CAC)

203

Schartz, H.J., E. Nowak-Foery, and H. Geissler, Kraftanlagen AG, Heidelberg, Federal Republic of Germany

Development of a Transportable Decontamination Station for Waste Water Treatment After Decommissioning of Nuclear Facilities

Kraftanlagen A.G., Heidelberg, Federal Republic of Germany; 151 pp. (1984)

After a general description of the waste disposal concept and the major decontamination steps and processes, the amount of waste water to be treated is calculated, and a suitable waste water treatment process for the transportable decontamination station is selected. The rentability of the transportable versus a stationary plant is assessed. The mobile system has the advantage of low cost and low risk, owing to the fact that the liquid waste need not be transported.

204

Schenker, E., Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland

Decontamination by Means of High Pressure Water

Schweizerische Technische Zeitschrift 81(11):14-15, 17 (1984, May 30)

It has been found that high pressure water can be used to cleanse metal surfaces from radioactive contaminants which, in nuclear power plants, consist mainly of activated corrosion products; i.e. isotopes Co-60, Ag-110m, Mn-54, Sb-125, etc. These have, relatively speaking, a long life and show a high gamma energy. Tests using this method on reactor probes are described and results, expressed in the form of a graph: water pressure (bar) versus residue radioactivity was very encouraging. Future work will be aimed at optimizing the nozzle design for range and spread of jet.

205

Shaw, R.A., and C.J. Wood, Electric Power Research Institute, Palo Alto, CA

Chemical Decontamination: An Overview

Nucle r Nev. 3):107-111 (1985, June)

Practical and proven decontamination technology has become available for utility application at a time when there is a growing need to reduce radiation doses resulting from major maintenance and repair requirements. Recent experien at nine plants that have contaminated reactor coolant systems has highlighted both the bad and good features of the existing technology. On the positive side, the estimated dose savings is 2169 person-rems pe plant. Estimating the average cost of the decontamination and waste handling to be $1 million, then the cost per person-rem saved is about $460, which is highly cost-effective. On the other hand, each of the nine plants surveyed reported operational problems associated with the decontamination. These problems usually have not been serious and have generally been solved on a plant-by-plant basis. They do, however, indicate that improved quality control of equipment and connections, with increased preoperational testing, can significantly improve operations. (JWF)

206

Suwa, T., and H. Yasunaka, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Present Status of Decontamination Technology for Nuclear Reactors

Boshoku Gijutsu 32(12):721-729 (1984)

Decontamination of deposits in the primary cooling circuits of pressurized water reactors and boiling water cooled reactors using chemical decontamination agents is described. Also described are a number of nonchemical decontamination methods, including dry and wet blast, microwave, use of strippable coatings, and electropolishing.

207

Tamberg, T., Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Decontamination of Surfaces

Amts und Mitteilungsblatt der Bundesanstalt fuer Materialpruefung 14(1):12-15 (1984, March)

An analysis of the risks related to surface contamination and a discussion of the associated material damage is presented. A description is given of various nuclear technology activities from which surface contamination will often times result. Two case studies are described to point out the extent of the contamination and the results of practical decontamination projects. Results of the surface decontamination work ongoing at the Bundesanstalt fuer Materialpruefung (BAM) laboratory are also given. The laboratory is involved with standards and testing, ability to decontaminate surfaces, efficiency of decontamination cleansing and washing agents, and development of appropriate testing procedures. (PTO)

208

Turner, A.D., J.S. Pottinger, and A.R. Junkison, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, United Kingdom

Electrochemical Decontamination of Plutonium Contaminated Stainless Steel

AERE-R-10506 (1983, August)

Electrochemical decontamination has been demonstrated to be very effective in removing plutonium nitrate contamination (0.5 ug/sq cm) on stainless steels. The amount of metal dissolved to achieve a decontamination factor of 100 to 1000 ranged from 2 to 7 microns depending on the electrolyte used. In unstirred electrolytes 1 M HNO_3, 1 M HNO_3/0.1 M NaF, 5 M HNO_3 perform best. Under stirred electrolyte conditions, there is a general marginal fall in effectiveness except for 5 M HNO_3 where there is slight improvement. The optimum performance is a compromise between maximizing the electrolyte throwing power and minimizing substrate surface roughening during decontamination.

209

U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, DC

Answers to Frequently Asked Questions About Cleanup Activities at Three Mile Island, Unit 2

NUREG-0732 (Rev. 1); 56 pp. (1984, March)

This question-and-answer report provides answers in nontechnical language to frequently asked questions about the status of cleanup activities at Three Mile Island, Unit 2. The answers update information first prepared in 1981, shortly after the cleanup got under way. Since then, a variety of important developments in the cleanup has occurred. The information in the report should be read in conjunction with NUREG 1060, a discussion of increased occupational exposure estimates for the cleanup. The questions and answers in this report cover purpose and community involvement, decontamination of water and reactor, fuel removal, radwaste transport, environmental impact, social and economic effects, worker exposures and safety, radiation monitoring, potential for accidents, and scheduling and funding.

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210

Verry, P., and Y. Lecoffre, Commission of the European Communities, Luxembourg, Luxembourg

Surface Decontamination by Cavitation Erosion

EUR-8956; 24 pp. (1984)

The purpose of the study is to show the applicability of using erosion by cavitation to remove a thin layer of matter from an irradiated surface during nuclear power plant dismantlement. The advantages of using this method are that it can be used in liquid medium and it does not produce any aerosols. Several cavitation devices were tested on different surfaces to erode: aluminum, stainless steel, Plexiglas, and paints. The process is efficient enough to measure mass loss on materials as hard as stainless steels using a pressure of only 60 bars. Qualification tests using a nozzle feed under a 300 to 600 bar pressure are planned.

211

Voit, R.E., NUS Process Services Corporation, Columbia, SC

Advances in Decontamination Technology

Transactions of the American Nuclear Society 43:127-129; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 127-129) (1982)

Decontamination technology in the nuclear industry has advanced significantly over the last decade as the rapid increase in nuclear waste disposal costs stimulated the growth from conventional scrubbing methods to more advanced methods of decontamination. Many of these methods were adapted from various cleaning and machining work in the nonnuclear industry. Recently, another nonnuclear cleaning technique has been modified for nuclear decontamination applications and introduced to the U.S. nuclear industry. This technique is called liquid abrasive blasting. It has the potential of being the most effective and efficient decontamination technology yet introduced and will be proved at various nuclear facilities in the United States during 1982.

212

Woollam, P.B., Central Electricity Generating Board, Berkeley Nuclear Laboratories, Berkeley, United Kingdom

An Assessment of the Data for Decommissioning Calculations on Ag-108 Metastable

RD/B/N4373; DECOM-78/6; CNDC/(78)P10; 6 pp. (1978, September)

The mild steel activation product Ag-108m was thought to be the isotope which would limit personnel exposure, and hence access, during the dismantling of a Magnox steel pressure vessel reactor. This could have arisen if the structure were left to decay for a period of approximately 100 years after final shut down. Because the significance of this little-known isotope was potentially so great for decommissioning studies, a survey of the literature was undertaken, together with a further series of measurements, to check the accepted data on this nuclide. An assessment of this data has produced the following conclusions: The thermal cross-section for the reaction Ag-107(n, gamma) Ag-108m is 0.37 plus or minus 0.07b. The generally accepted value in the literature, 3 plus or minus 1.5b, is incorrect. Although the half-life of Ag-108 quoted in the literature was measured in the presence of low levels of contaminating Ag-110m, no allowance was made for this short lived isotope in calculating the accepted value of 127 plus or minus 7 years. Re-analysis of the original data indicates that a half-life of 145 years would be more accurate. The generally accepted data for gamma-ray emissions from the decay of Ag-108 are correct. No significant lines have been observed other than those from the 90% abundant triple cascade at 434, 614, and 723 keV. The predicted dose equivalent rate to personnel working inside the steel pressure vessel of a Magnox reactor 100 years after shutdown is a factor of 4 lower, using the data presented here, than that previously accepted. However, this reduction is not sufficient to predict that unrestricted access will be permitted to this area at this time. (Auth)

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Abe, T., T. Aota, T. Nishizaki, S. Nakayama, and S. Yamashita, Kawasaki Heavy Industries Limited, Kobe, Japan

Status of Underwater Plasma Arc Cutting at Kawasaki Heavy Industries - 2

FAPIG 102:56-62 (1982, November)

Kawasaki Heavy Industries, Limited, (KHI) has developed a cutting technique for dismantling steel structures for specific application to the decommissioning of nuclear facilities. The technique adopted is underwater plasma arc cutting. The apparatus was acquired and experimental facilities were installed. The purpose of the experiment was to establish a remotely-operated cutting system. In this report, the test facility installed, the underwater plasma cutting equipment used, and the results of the test performed are summarized. The cutting capability of the M-200 torch operated underwater was 2/3 of the torch's capability in air. The M-200 torch has the plasma gas supplied in a swirling flow. The remotely-operated automatic cutting capability was achieved by utilizing sequence control. The torch used was the 1000 A, Class O torch developed by Thermal Dynamics Company. The report explains the following components and aspects of the cutting system: (1) pool for underwater experiments, (2) pool water-purifying system, (3) the plasma arc cutting system, (4) sequence controller for plasma cutting, (5) gas-controlling box, (6) underwater manipulator, (7) experimental setup, (8) cutting conditions, and (9) experimental results. (PTO)

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Abe, T., T. Aota, T. Nishizaki, S. Nakayama, and S. Yamashita, Kawasaki Heavy Industries Limited, Kobe, Japan

Status on Underwater Plasma Arc Cutting at Kawasaki Heavy Industries - 3

FAPIG 104:33-37 (1983, July)

Kawasaki Heavy Industries, Limited has developed a remote dismantling system which utilizes an underwater plasma arc cutting process. This process aids in dismantling and removing component from nuclear reactor facilities. In previous reports, the preliminary experimental results, such as the comparison of cutting capability in air and in water, were given. The use of remote automatic cutting of wedge-shaped specimens using a newly installed manipulator for underwater works is detailed in this report. A comparison is made of cutting capability according to position of apparatus and cutting direction (overhead position, vertical position - upward and downward direction, and horizontal position). It is important to understand the cutting characteristics, particularly upward advancing and downward advancing cutting in overhead and vertical positions when cutting pressure vessels and horizontal pipes. The underwater plasma arc cutting device can cut all metals. The experimental apparatus, the cutting conditions, the testing method, and the test results of the cutting capability and ability of the apparatus to change direction during cutting, and the remote cutting of pipes into rings are described. The device has a relatively high cutting speed, is compact, and is easy to operate. (PTO) (RCF)

215

Ackermann, U., and E. Ratsch, Versuchsanstalt and Deutsche Forschungs-u Lift-u Raumfahrt eV, Cologne, Federal Republic of Germany

Noiseless Combustion and Plasma Cutting Arrangement

U.S. Patent 4,438,316 (1984, March 20)

The invention relates to a noiseless combustion and plasma cutting arrangement with a cutter and an associated gridiron-or honeycomb-type bench that is divided into individual cells that are higher than they are wide to reduce the noise that occurs during cutting.

216

Ales, M.W., J.D. Connell, R.V. Demars, and D.A. Nitti, Babcock and Wilcox Company, Lynchburg Research Center, Lynchburg, VA

Equipment for Removal of the TMI-2 Plenum Assembly

GEND-INF-051 (1984, June)

Preliminary examinations have shown that the plenum assembly is distorted and possibly might bind against the reactor vessel and core support shield as it is lifted. Further, fuel assembly components are stuck to the bottom of the plenum assembly and particulate fuel debris is deposited in the plenum assembly. These conditions require special equipment to free the plenum assembly from the reactor internals, to dislodge suspended fuel assembly remnants and to lift, transfer, and store the plenum assembly in the shallow end of the refueling canal. The special equipment to remove the plenum assembly is being designed and built. This equipment includes an integrated video/communication inspection system; a hydraulic jack system with a 240-ton capacity; specially designed tools to dislodge the end fuel assembly fittings from the plenum assembly; a portable work platform; and final lifting equipment and a transfer contamination barrier that will be used in conjunction with the polar crane to lift and transfer the plenum assembly. Test assemblies necessary to check out the performance of equipment and train personnel are also being provided.

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Bach, F.W., R. Bisci, B. Boedeker, J. Klare, H.G. Knackstedt, and F. Piana, University of Hannover, Hannover, Federal Republic of Germany; Commission of the European Communities, Brussels, Belgium; Noell (G.G.) GmbH, Wuertzburg, Federal Republic of Germany; Salzgitter AG, Salzgitter, Federal Republic of Germany; Transnuklear GmbH, Hanau, Federal Republic of Germany; Ansaldo Impianti, Genoa, Italy

Dismantling Techniques for Steel Components

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 229-237) (1984)

This program examined possibilities for solving the dismantling problems in the reference BWR reactor with thermal cutting techniques. It was shown that the stainless steel plated wall of the reactor pressure vessel, with a thickness of 600 mm, can be dismantled by plasma-autogen-combination cutting. Further research work was done to find the efficiency of oxygen lance piercing and powder flame cutting, especially on parts that cannot be done, or can be done only with great difficulty, by flame cutting. It was found that oxygen lance piercing gives the best results, when it is done manually. A special dismantling problem was the recirculation inlet tube at the vessel wall with only a small clearance between the tube and wall. It was solved by using the plasma arc cutting in air as well as under water. The mastering of dust and aerosol emission by application of the thermal cutting techniques is a serious problem for the future. The comparison of the dust and aerosol emission by plasma arc cutting in air and under water show a sizable reduction of the emissions by cutting under water. (Auth)(JWF)

218

Bach, F.W., H. Haferkamp, and H. Osterlitz, University of Hannover, Hannover, Federal Republic of Germany

Combined Plasma Arc/Gas Cutting of Cladded Components of Up to 600 mm Wall-Thickness

Thermal Cutting and Flame Processes, Proceedings of the International Institute of Welding Annual Assembly, Ljubljana, Yugoslavia, September 7, 1982 (1982)

This report describes the development and testing of a combined plasma torch and oxyacetylene torch to cut metal plate during the dismantlement phase of nuclear power plant decommissioning. Tests were conducted on ST37-2 steel with wall thickness up to 600 mm and on 10CRNiTi188 Cr-Ni steel with clad plate thickness of 10 mm. Various cutting positions (flat, horizontal, vertical upward, and vertical downward) were tested. (CTO)

219

Bengel, P.R., M.D. Smith, and G.A. Estabrook, GPU Nuclear Corporation, Middletown, PA

TMI-2 Reactor Vessel Head Removal

GEND-INF-062; 99 pp. (1984, December)

This report describes the safe removal and storage of the Three Mile Island Unit 2 reactor vessel head. The head was removed in July 1984 to permit the removal of the plenum and the reactor core, which were damaged during the 1979 accident. In July 1982, plans and preparations

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were made using a standard head removal procedure modified by the necessary precautions and changes to account for conditions caused by the accident. After data acquisition, equipment and structure modifications, and training, the head was safely removed and stored and the internals indexing fixture and a work platform were installed on top of the vessel. Dose rates during and after the operation were lower than expected; lessons were learned from the operation which will be applied to the continuing fuel removal operations activities.

220

Birkhold, U., F. Krieger, and U. Freund, Noell (G.G.) GmbH, Wuertzburg, Federal Republic of Germany

Explosive Demolition of Biological Shielding of the Nuclear Power Station Niederaichbach

CONF-830636; Jahrestagung Kerntechnik '83 (Nuclear Technology '83), Proceedings of a Conference, Berlin, Federal Republic of Germany, June 14-16, 1983; (pp. 808-811) (1983)

The complete removal of the Power Station Niederaichbach requires that the radioactive inner layer of the heavy-concrete shielding be removed separately. A technique has been developed and tested, whereby a 60-cm thick inner layer of the concrete wall can be separated by explosive charges.

221

Bittner, A., D. Jungwirth, M. Knell, and L. Schnitzler, Bundesministerium fuer Forschung und Technologie, Bonn, Federal Republic of Germany; Dyckerhoff and Widmann AG, Munich, Federal Republic of Germany; Abteilung Forschung, Entwicklung und Qualitaetssicherung, Federal Republic of Germany

Investigations on Construction Material and Construction Concepts in Order To Obtain Dose-Reducing Effects in the Dismantling of the Biological Shield of a 1300 MW(e)-PWR - Final Report

INIS-mf-9270; 160 pp. (1984, April)

Design concepts are presented for the construction of concrete biological shields for PWRs. The purpose for developing new shield designs is to reduce radiation exposure. Neutron flux, neutron activation, and dose rate data are presented to aid in the evaluation of suggested shield designs. Suggested designs utilize various materials selected for precast elements, some incorporating an external boron carbide layer.

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Budke, W.C., BVC Consultants, Inc., Sun City Center, FL

Sectioning of Contaminated Materials and Electrochemical Decontamination

EPRI-NP-3222; CONF-830162; Proceedings of the 1983 American Society of Mechanical Engineers and Electrical Power Research Institute Radwaste Workshop, B.V. Coplan (ed.), Charlotte, NC, January 31, 1983; (pp. 77-85) (1983, August)

Large amounts of surface contaminated metal waste is generated annually by operating utilities and by the decommissioning of obsolete facilities. This waste, especially that contaminated with transuranic elements, creates a problem of transportation, storage, and ultimately geological disposal. Ongoing work at Allied Consulting demonstrates that electropolishing techniques can be an effective tool in removing transuranic and other radionuclide contamination from metallic surfaces. Work includes the sectioning and processing of PWR spent fuel racks in preparation for decontamination by electropolishing. Several sectioning techniques are employed with varying degrees of success, including plasma arc torch and mechanical saws. Plasma arc torch is a very rapid and effective metal cutting tool on size reduction and sectioning applications. However, its use to prepare materials for decontamination is minimized because of problems with smoke generation, torch manipulation, waste generation and entrainment of contaminants. Mechanical saws eliminate most of these problems but the waste generation. Our work to date demonstrates that with certain requirements, contaminated components can be sectioned safely, efficiently, and with minimal waste generation into sizes needed for subsequent decontamination by electropolishing. Requirements include proper design of the sectioning facility, flexibility in its mode of operation, and the use of appropriate combination of available industrial metal cutting techniques.

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Conn, A.F., and G.S. Frederick, Hydronautics, Inc., Laurel, MD

Reducing/Separating Recoverable Demolition Wastes with Cavitating Water Jets

TR-8226/1; NSF/MEA-82029; PB-84-221829; 79 pp. (1982, March)

Results are presented of a project to determine the feasibility of using cavitating water jets to reduce the size of building debris, thus facilitating separation of materials for recycling. Slot cutting experiments were conducted on blocks of concrete containing steel reinforcing bars, which were taken from recently demolished buildings. Slot configurations were determined as a function of the pressure, water flow, and rate of translation for various nozzles. The results suggest that a 208 kW cavitating jet system should be capable of separating steel re-bar and concrete debris at an effective average rate of at least 41 tons per hour, at a cost of about $1.42 per ton.

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Davies, I.L., A.R. Gregory, and H.G. Knackstedt, Taylor Woodrow Construction Limited, Southall, Middlesex, United Kingdom; Central Electricity Generating Board, Generation, Development, and Construction Division, Gloucester, United Kingdom; Transnuklear GmbH, Hanau, Federal Republic of Germany

Demolition of Concrete Structures

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 252-266) (1984)

Many methods have been developed for the demolition of conventional concrete structures, but when the special requirements associated with the demolition of structures in nuclear facilities are imposed, considerable revision in working practices is essential. In fact, when these requirements are introduced some of these conventional techniques are completely inappropriate and all other methods need considerable development. This paper outlines work which has been undertaken under the auspices of, and with support from, the Commission of the European Community in their research program on the decommissioning of nuclear facilities. It considers the methods which appear to be most promising and reviews them under three main headings: (1) mechanical systems, (2) chemical techniques, and (3) thermal methods. Rubble, dust, slag, or smoke arising from the various cutting methods is of enormous importance because it is this active waste material which presents the final problem of disposal. Activity of concrete is low but the reinforcing presents difficulties. It is important that cutting methods should not increase the quantity of radioactive materials arising from the demolition process. It may be concluded from the work completed that it will be possible to remove activated concrete from nuclear structures in a way which insures that radioactive materials cannot escape into the environment. Further developments are required to bring procedures to a state where they may be completely acceptable to regulating authorities. (Auth)

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Eickelpasch, N., L. Berkemann, G. Loercher, and P. Pfeiffer, Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Federal Republic of Germany

Activation of the Biological Shield in the Decommissioned Gundremmingen Block A Nuclear Power Plant

EUR-8950 (1984)

In the planning of the dismantling of the Gundremmingen Block A nuclear power plant, a knowledge of the depth of radioactivation of the biological shield (e.g. concrete) is significant. To obtain this information, an extensive sampling and measuring program was used to support calculations derived through use of a computer program. By comparing the measured results with the calculated data, the parameters for dismantlement can be determined which in later projects will avoid an expensive measurement program. The measured and calculated results agreed very well.

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Flasskamp, H.

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Measures To Cut Noise and Dust During Plasma Cutting

Bander-Bleche-Rohre 24(3):69-73 (1983, March)

Plasma cutting in its various forms falls under the heading of heat-based parting-off processes and together with autogenous flame cutting has become firmly established in industry. The process of plasma cutting is inevitably accompanied by the generation of noise, radiation, fumes, and gasses. Ear muffs afford protection against noise while infra-red and ultra-violet radiation can be combatted by the wearing of goggles. Extraction benches assembled on the modular construction principle draw off dust and gasses mainly at their point of origin below sheet metal to be cut. (AA)

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Flasskamp, H.

Underwater Welding and Cutting

Schiff Hafen 36(5):63-65 (1984, May)

Welding and cutting underwater with a hand electrode has gained wide acceptance in off-shore engineering and in nuclear reactor engineering. Techniques described are MIG/MAG welding, hyperbar TIG welding and underwater plasma cutting. The choice of technique depends on the work conditions; e.g. greater depth as in off-shore work or greater thickness as in nuclear engineering. Each technique is described and illustrated. (RNB)

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Flasskamp, H.

New Experiences with Plasma Cutting of Unalloyed and Highly Alloyed Steels

Schweissen und Schneiden [English translation, "Welding and Cutting"], Deutscher Verlag fur Schweissentechnik GmbH, Dusseldorf, Federal Republic of Germany; (pp. 126-129) (1984)

The principles of plasma cutting and a number of variations are discussed. The use of Ar-H mixtures in a ratio of 3:2 permits safer ignition of the plasma because of the low ionization energy of Ar, higher impulse density of the plasma flow because of its high atomic weight, resulting in better ejection of the melt from the cut. For carbon steels, a proprietary gas mixture is used to prevent stringer formation. Use of compressed air as the plasma gas requires the replacement of tungsten electrodes by Zr or Hf alloys which must be effectively and directly water cooled; high cutting rates and good cut quality are obtained in C steels. The water-injection plasma technique uses nitrogen as the plasma gas with the additional spray-in of water. This simplifies torch construction since cooling water need not be recirculated and electrode life is considerably extended. The PMC-green method is a synthesis of the preceding variants. Underwater plasma cutting reduces noise and fumes and can be performed either with the bottom of the cut only submerged or with the whole piece under water. (BL)

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Freemerman, R.L., and R.L. Rider, Bechtel Power Corporation, San Francisco, CA

Preparing for the Reactor Head Lift

Nuclear Engineering International 29(356):23-26 (1984, June)

Progress being made toward removal of the reactor vessel head at Three Mile Island Unit 2 nuclear power plant is discussed. While the radiation levels under the head require additional precautions beyond those taken during normal plant operation, current plans will allow the head to be removed safely. Core data, polar crane refurbishment, reactor pressure vessel head removal, access to the vessel and removing the plenum assembly are discussed.

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Present State of Development of Nuclear Reactor Dismantling Techniques

Genshiryoku Shiryo 147:5-30 (1983, April)

With the development of nuclear power generation and in connection with the location of nuclear power stations, it has become important to establish appropriate countermeasures after the end of operation of nuclear reactors. Assuming the operation term of nuclear reactors to be 30 years, about a half of 24 nuclear power stations now in operation will end their life 25 years from

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now. The method of decommissioning nuclear reactors is classified into sealing off and management, shielding isolation, and dismantling and removal. In Japan, the desired method of dismantling and removal would protect the land and establish the public acceptance. The basic policy on decommissioning measures for nuclear reactors was decided in the "Long term plan of development and utilization of atomic energy" in June, 1982. The research on the development of reactor decommissioning techniques was started in Japan Atomic Energy Research Institute in fiscal 1981. In this report, the present status of the development and the trend in foreign countries are de⁻ribed.

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Hamasaki, M., M. Katsumura, and F. Tateiwa, Government Industrial Research Institute, Shikoku, Japan

A Study of Underwater Cutting for Commercial Reactor Pressure Vessels

Fundamental and Practical Approaches to the Reliability of Welded Structures, Proceedings of the Fourth International Japanese Welding Society Symposium, Osaka, Japan, November 24-26, 1982; (pp. 193-198) (1982)

Commercial reactor pressure vessels are dismantled underwater for radiation shielding. A new and simple underwater cutting method for vessels made of stainless-clad steel is proposed, and fundamental and practical data are given. From the results it is clear that satisfactory cutting results of 300-350 mm stainless-clad steel could be obtained if the proper cutting conditions were selected.

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Hamasaki, M., and F. Tateiwa, Government Industrial Research Institute, Shikoku, Japan

Gas and Dross in Underwater Cutting Using Consumable Electrode Water Jet Cutting Technique

Koon Gakkaishi 10(1):18-23 (1984, January)

A new consumable electrode water jet cutting technique has shown to be superior to the plasma-arc cutting technique as a cutting method for dismantling nuclear reactor components and equipment. Specific advantages of the water jet cutting method are cutting ability and recoverability of dross. Cutting was carried out at a water depth of about 30 cm with a stainless steel plate workpiece and a mild steel wire electrode. Gas was recognized in underwater cutting in spite of the fact that no shielding gas was used. The gases, hydrogen, nitrogen, and oxygen, were released by arc heat. The gas, which increased with increasing current, was generated at a rate of 5 l/min at a current of 700 A. The dross was an alloy made from melting stainless steel and mild steel wire. The nonmagnetic stainless steel was converted to magnetic dross as a result of the process, which allowed for the recovery of 98.5% to 99.7% of the dross by the use of a magnet. (PTO)

233

Hamasaki, M., and F. Tateiwa, Government Industrial Research Institute, Shikoku, Japan

Underwater Gouging of Stainless Clad Steel Using Mild Steel Strip

Yosetsu Gakkaishi 52(3):277-281 (1983, March)

Underwater cutting has been shown to be an excellent method for the dismantlement of pressure vessels from retired commercial nuclear power plants. In addition to cutting efficiency, another advantage of underwater cutting is that it provides shielding the operators and the reactor-site from resulting radiation emissions. The pressure vessels to be cut are made of 150-250 mm thick carbon steel with 18-8 type stainless steel cladding 6 mm to 12 mm thick. The underwater cutting must be carried out from the stainless steel side. Underwater gouging is a process which melts the stainless steel clad by arc heat. The arc heat is generated from a mild steel wire or strip which acts as an electrode. The material is then blown out by jetting water from a rear nozzle. Continuous gouging can be done by an automatically travelling carriage. Gouging current flows discontinuously at a speed of 15-20 cm/min. (PTO)

234

Harbecke, W., W. Lambers, G. Loercher, and M. Seidler, Kernkraftwerk Lingen GmbH, Lingen, Federal Republic of Germany

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DISMANTLEMENT AND DEMOLITION

Activation of the Biological Shield in the Decommissioned Lingen Nuclear Power Plant

EUR-8801; 59 pp. (1984)

Part of the information needed in the planning of the dismantling of a nuclear power plant is the extent of radioactivation of the biological shield. By using an extensive sampling and measurement program at the decommissioned Lingen Nuclear Power Plant to support the calculations of the radioactivity obtained by using a computer program, the prerequisites were determined which will avoid an expensive measuring program in later projects. The measured and calculated results agree well with each other. A calculation of the activity in the core-midplane suffices to determine the region away from which the concrete is only negligibly activated. In the Lingen Nuclear Power Plant, which was examined, this region lies just in front of the outermost concrete (the 1st concrete).

235

Hashish, M., J.M. Reichman, and M.C. McDonald, Flow Industries, Inc., Kent, WA

Development of a Water-Jet Concrete-Cutting System: Volume 2, Abrasive Water-Jet Systems - Final Report

EPRI-EL-3601 (Vol. 2); 92 pp. (1984, September)

This report represents all testing and analysis of abrasive waterjet cutting technology performed by Flow Industries Inc. under EPRI research contract RP7860-1. Prior work, described in Volume 1, emphasized pure waterjet technology for purposes of cutting roadgrade substrates. Because of inadequate cutting, abrasive augmented waterjets at reduced pressures were pursued in order to meet this contract's objective of developing a mobile, self-contained pavement cutter for the underground utilities industries. Through use of abrasive sands and 35, 000 psi water superior cutting of concrete and other hard materials was done. This report, which is Volume 2 of a three-volume final report, describes all of the variations on nozzle designs and tests necessary to the success of the prototype pavement cutter. Volume 3 covers this pavement cutter's field demonstration and its effective cutting performance in Seattle, Washington.

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Holmes, A.

Irradiated Concrete Maze Is Confronted by Robotics - Uncertainties of Nuclear Reactor Decommissioning

Energy Economics 35:5-7 (1984, September)

Nuclear reactor decommissioning and demolition are discussed. Three stages of the process are defined, and three options are described, depending on the rate at which the stages of the process are carried out. The options are: immediate decommissioning and demolition within 10 to 15 years of shutdown; partial deferment, the final stage being deferred for 10 to 100 years; total deferment, the second and third stages being deferred for 50 years or more. The possibilities and problems of designing a task-specific robot to carry out decommissioning are discussed. It is pointed out that specialist demolition will be needed. The problem of massive amounts of radioactive waste disposal is considered. The large unknown cost of the operation, and the desirability of getting experience in the problems involved, are discussed.

237

Ito, N., T. Egashira, and T. Fujita, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Project of Developing Dismantling Techniques for Nuclear Reactors in Japan Atomic Energy Research Institute

Genshiryoku Kogyo 29(6):17-44 (1983, June)

Investigation and research on the decommissioning of nuclear power stations have become active since 1975. About half of 24 nuclear power stations now in operation will reach the end of their life after 20-25 years. The importance of decommissioning measures for nuclear power stations has been recognized. The Atomic Energy Commission included the decommissioning measures for nuclear power stations in the long term plan of the development and utilization of atomic energy decided in June, 1982, and the summary is described. In the JAERI, the elementary techniques for dismantling nuclear reactors will be developed, and those will be applied to the dismantling of the Japan Power Demonstration Reactor which has already ended its role in the JAERI. The project for this purpose was set up in September, 1981, and by the end of 1989, it is scheduled to remove all the facilities and to level the evacuated land. The background and the contents of the project, such as the system engineering of dismantling, the technique of evaluating radioactive inventory, the nondestructive measurement of radioactivity, the method and equipment for dismantling and others are described.

238

Kawakami, M., Koike Sanso Kogyo Company, Limited, Japan

Process and Apparatus for Exhausting Fumes and Oxide Particles Generated by Plasma-Arc Cutting Machine

U.S. Patent 4,441,934 (1984, April 10)

A process and apparatus are described for absorbing and exhausting efficiently dust (oxide particles), fumes, smoke, harmful gases and the like generated by plasma-arc cutting. The lower space of a fixed board for supporting the material which is cut is divided by plural partition plates to the direction crossing at right angles with the driving direction of the cutting machine body, an absorbing hood connected with a dust collector through a duct is installed and fixed to the cutting machine body in order to exhaust from the side of partition space corresponding to the plasma-arc cutting torch, fumes in each partition space at every position of cutting at the shortest distance and efficiently by making the absorbing hood move together with the movement of the cutting machine body. A reduction of the dust collector's capacity and a simplification of the accessory equipment are possible and cost reduction of the equipment for exhausting smoke including dust, fumes and the like in the plasma-arc cutting machine is possible.

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Kinugasa, M., S. Taguchi, S. Ohzeki, Y. Inoue, and S. Kashima, Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, Tokai, Ibaraki, Japan

Evaluation of Decontamination During Dismantling of Plutonium-Contaminated Glove Boxes

PNCT-831-81-01; Annual Progress Report of Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, April 1980-March 1981; (pp. 16-25) (1981, September)

The dismantlement of plutonium-contaminated glove boxes, which had been used for 15 years in R&D of plutonium-uranium mixed oxide fuel, is discussed. The work was carried out in a pressure-controlled greenhouse which was equipped for continuous monitoring for air contamination. In order to reduce the contamination of air during dismantlement, the decontamination and fixation of loose contaminants on the surfaces of glove boxes were very important. The correlation between decontamination and the contamination of air during dismantlement is reported in this paper. The surface contamination density of the glove boxes was measured utilizing the smear method before and after the decontamination, and the decontamination effects were determined. The contamination of air during dismantlement was continuously measured with a plutonium dust monitor. It was found that loose contamination exponentially decreased as a result of the decontamination process. When the so-called wet glove boxes, which contained wet recovery and waste disposal apparatus, were dismantled, the air contamination did not exceed 500 (MPC for air). However, air contamination did exceeded 500 (MPC for air) several times during the dismantling of the so-called dry glove boxes which had been used for the fabrication of plutonium-uranium mixed oxide pellets. (PTO)

240

Kloj, G., and G. Tittel, Commission of the European Communities, Luxembourg, Luxembourg

Thermal and Mechanical Cutting of Concrete and Steel

EUR-8633; 96 pp. (1984)

Various thermal and mechanical processes for dismantling large radioactively contaminated components and concrete structures were investigated in order to determine the optimal handling conditions and their respective efficiencies. Thermal processes including oxygen lances, power cutting, and oxyacetylene cutting were tested and evaluated for the dismantlement of heavy concrete and steel components. The primary mechanical process tested was the use of stationary saws. Because of the large size of many of the contaminated components in a nuclear installation, it is not feasible to use these saws for initial dismantlement. The saws can be used for both low-alloy and austenitic steel, and for separating materials not containing iron. The main advantage that the saw technique has over the thermal processes is the low quantity of contamination (gas or dust) released. The amount of shavings (secondary waste) produced by the saws is also very low. Another advantage of the saws is operability by remote control. (DCM)(PTO)

241

Lindsell, P., University of Surrey, Department of Civil Engineering, Guildford, England

Close Links Between Design and Demolition

Surveyor 163(4818):22-23 (1984, November 8)

Prestressed concrete is designed on the basis of limiting the compressive stresses to one-third of the crushing strength of the concrete under maximum live load conditions. The tensile stress allowed in the concrete is very small, and designs are often based on no tension under dead load and limited crack widths under full live load. The article contains some practical recommendations on the safe removal of prestressed concrete structures and underlines the close links between design and demolition.

242

Lingscheidt, G.

Special Thermal Cutting Processes - Their Operation and Future Prospects

Thermal Cutting and Flame Processes, Proceedings of the International Institute of Welding Annual Assembly, Ljubljana, Yugoslavia, September 7, 1982 (1982)

Application of thermal lances and power cutting are well known processes for the cutting of non-metallic and nonferrous materials. Precise investigations have resulted in better knowledge on their performance and applicability for underwater cutting and remote controlled cutting of contaminated materials of nuclear power stations.

243

Loiseau, P., Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Paris, France

Remote Handling Equipment To Cut Metallic Tubes and Plates in Dangerous Atmosphere

French Patent 2,524,367/A/ (1983, October 7)

A remote control pyrotechnic device to cut plates and tubes is described which is particularly useful for mechanical piece dismantling in a contaminated atmosphere. The device is compact, easy to use, inexpensive and can be disposed of with metallic wastes after its utilization. The device is described in detail, and the method of operation is also described.

244

Masters, R.

Power Cutting Keeps Its Flexibility

Nuclear Engineering International 29(385):35-38 (1984, August)

Unique experience in steam generator and BWR pipework replacement is being applied by a small company, Power Cutting, to the development of more automated equipment that will improve efficiency and reduce operator exposure. This is made possible through a combination of robotics, remote control and the extensive use of mock-ups for crew training, prior to actual application. The company, recently purchased by Westinghouse, will retain the flexible engineering approach that enables it to respond quickly to calls for help. (JWF)

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McDonald, M.C., J.M. Reichman, and M. Hashish, Flow Industries, Inc., Kent, WA

Development of a Water-Jet Concrete-Cutting System: Volume 3, System Equipment and Testing - Final Report

EPRI-EL-3601 (Vol. 3); 34 pp. (1984, September)

A high-pressure, abrasive water-jet system that removes road-grade pavement offers utilities a financially attractive way of reducing the installation costs of underground cables. This system, mounted on a vehicular power supply and street tested, demonstrated that it can economically and quietly achieve cutting depths of up to 8 in.

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Migliorati, B., and P. Gay, Fiat, Termomeccanica-nucleare e Turbogas, Torino, Italy; Fiat, Centro Ricerche Fiat, Orbassano, Torino, Italy

Advanced Cutting Techniques: Laser and Fissuration Cutting, Part 2 - Laser Beam Cutting

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 244-251) (1984)

Experimental tests have been performed using CO2 laser with output power from 1-15 kW to evaluate the effects of varying the following parameters: (1) material (carbon steel Fe-42-C, stainless steel AISI-304, concrete), (2) laser power, (3) beam characteristics, (4) work piece velocity, (5) gas type, and (6) distribution on the laser interaction zone. In the case of concrete, drilling depths of 80 mm were obtained in a few seconds using a 10 kW laser beam. Moreover, pieces of 160 mm were cut at 0.01 m/min. Results with carbon steel indicate maximum thicknesses of 110 mm, cut at 0.01 meters m/min with 10 kW; depths about 20% lower were obtained with AISI-304 stainless steel. A parallel investigation was aimed at characterizing particulate emission during the laser cutting process. At the end of the research, it was possible to elaborate a preliminary proposal concerning a laser-based dismantling system for the application to a typical nuclear power station. (Auth)

247

Molin, C., Swedish Cement and Concrete Research Institute, Stockholm, Sweden

Localized Cutting in Concrete with Careful Blasting: Full-Scale Experiments in an Old Concrete Building with a Comparison of Methods

CONF-830840; CIB '83, To Build and Take Care of What We Have Built with Limited Resources, Volume 2: Building Technology, Design and Production, Proceedings of the Ninth CIB Congress, Stockholm, Sweden, August 15-19, 1983. National Swedish Institute for Building Research, Gavle, Sweden; (pp. 551-563) (1983)

Conversion (rehabilitation) operations in buildings constructed of concrete will increase markedly and so consequently will the need of methods adapted to this type of technology. Full scale experiments carried out by the Swedish Cement and Concrete Research Institute in an old concrete building were intended to extend and improve the methods available for localized cutting and partial demolition. These field tests indicate that blasting is technically and economically feasible. The method also offers an acceptable working environment.

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Nakaya, M., T. Kitagawa, and S. Satake

Concrete Cutting with Abrasive Waterjet

CONF-8406223; Jet Cutting Technology, Proceedings of the Seventh International Symposium, Ottawa, Ontario, Canada, June 26-28 1984; (pp. 281-292) (1984)

Different types of abrasives, Iron Grit and Aluminum Oxide were tested in order to decide the optimum conditions in concrete cutting, and their cutting abilities were investigated. As a result, Iron Grit which has larger specific gravity was more effective than that of Aluminum Oxide. Iron Grit had the advantages of abrasive recycling and slurry nozzle life. These results indicate the possibility of lower cost abrasive water jet cutting.

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Numata, K., H. Watanabe, H. Ishikawa, H. Miyo, and K. Ohtsuka, Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, Tokai, Ibaraki, Japan

In Situ Dismantling of Plutonium-Contaminated Glove Box

PNCT-831-80-01; Annual Progress Report of Power Reactor and Nuclear Fuel Development

Corporation, Tokai Works, January 1979-March 1980, Yasuji Nakamura (ed.); (pp. 98-105) (1980, September)

A plutonium-contaminated glove box was dismantled along with the development of treatment techniques for plutonium-bearing wastes. The objectives of this in-situ dismantling of the glove box are to reuse the Plutonium Fuel Fabrication Facility more efficiently, to reduce the volume of wastes generated during the dismantling, and to acquire dismantling techniques for decommissioning the Plutonium Fuel Fabrication Facility in the future. Prior to the dismantling works, a greenhouse for decontamination was installed, and the decontamination with surfactants was performed. Unremovable contamination was coated with paint. After this greenhouse was removed, the main greenhouse for dismantling and three greenhouses for contamination control were assembled. The main workers wearing protective devices engaged in dismantling apparatus in the greenhouse. As protective devices, anorak type PVC suits with air line masks, Howell type pressurized suits, and respirators were used. The tools used for the dismantling were a plasma cutter, an electric nibbler, an electric disk grinder, an electric circular saw and an electric jig saw. The results of the dismantling in-situ were compared with two previous cases of dismantling carried out by different procedures. In the case of in-situ dismantling, the volume of wastes was 1.6-1.8 cu m/cu m of glove box, and considerable reduction was realized.

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Otsuka, K., Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, Tokai, Ibaraki, Japan

Dismantling and Removal of Glove Boxes for Plutonium

UTNL-R-0110; Summaries of Environmental Safety in Nuclear Fuel Cycles: Fiscal 1979 and 1980; (pp. 41-44) (1981)

In plutonium fuel development in the Power Reactor and Nuclear Fuel Development Corporation (PNC), radioactive wastes are classified into those produced routinely and those resulting from the replacement of old equipment. For the management of such wastes, work done in and after fiscal 1976 is described, such as the dismantling and removal of glove boxes and also liquid waste tanks, including those for the mockup test and the actual operation. The purpose of the mockup test is to reduce the volume of wastes in dismantling by cutting glove boxes into pieces. Around a glove box, a "greenhouse" was constructed to prevent the spread of radioactivity. The glove box was cut with a plasma torch by workers within the greenhouse. For future study, there is the problem of operating with high efficiency.

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Perrin, J., and G. Tanis, Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Grenoble, France

Advanced Cutting Techniques: Laser and Fissuration Cutting, Part 1 - Fissuration Cutting

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 238-243) (1984)

The aim of this study is to develop a new method for cutting metal components of nuclear power plants, which produces virtually no secondary waste. In this method, a controlled intergranular fissure is produced in a heated area of the component by the addition of a molten material which gives rise to the formation of brittle compounds. With the presence of molten metal, the material or alloys in which there is tension can have a brittle intergranular failure. Generally the failure occurs in a defined temperature range. The tension stresses are created by the thermal gradient induced during the local heating. At the same time, the molten metal is added. This work has been developed in two directions: a study of the maximum thickness (presently it is potentially possible to cut sheets up to 100 mm thick), and an examination (just beginning) of dismantling of parts such as tubes, cans, and hot cell walls. (Auth)(JWF)

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Reichman, J.M., M. Hashish, and M.C. McDonald, Flow Industries, Inc., Kent, WA

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DISMANTLEMENT AND DEMOLITION

Development of a Water-Jet Concrete-Cutting System: Volume 1, Water-Jet Systems - Final Report

EPRI-EL-3601 (Vol. 1); 49 pp. (1984, September)

This report summarizes the work done by Flow Industries Inc. (FLOW) under research contract RP7860-1. The overall objective of this project was to design, fabricate, and test a self-mobile concrete cutting system for use in utility trenching operations. This volume of the final report covers the original work on high pressure waterjet technology and includes the test data and approach towards the design of the test vehicle. Several laboratory hardware tests were done along with a myriad of cutting tests in order to develop a cutting theory and establish jet and nozzle parameters for effective substrate cutting. This is Volume 1 of a three-volume set of reports. Volume 2 covers abrasive waterjet tests and design criteria at medium water pressures, and Volume 3 covers the field demonstration of the finalized cutting vehicle.

253

Romrell, D.M., and R.J. Webber, Hanford Engineering Development Laboratory, Richland, WA

Remote Cutting of Irradiated Fuel Ducts at FFTF

CONF-841105; Nuclear Power - A Global Reality, Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (p. 459); Transactions of the American Nuclear Society 47:459 (1984)

This paper describes both horizontal and vertical remotely controlled cutting of irradiated fuel ducts in the Interim Examination and Maintenance Cell (IEM) cell at the Fast Flux Test Facility (FFTF) located near Richland, Washington. The FFTF is a sodium-cooled test reactor, operated by the Westinghouse Hanford Company for the U.S. Department of Energy. The IEM cell is a vertical hot cell located within the FFTF containment building that was designed for disassembly and reassembly of experiments and fuel assemblies. Both horizontal and vertical duct cutting are performed using computer-controlled robotic techniques. The vertical duct cutting process is critical and must be controlled to within a plus or minus 0.0508 mm depth to prevent cutting through the duct surface and into the fuel pins. Horizontal cutting is performed in a similar manner. (PTO)

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Sakurai, S., K. Koibuchi, K. Ito, T. Omata, and M. Ookawara, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Method of Preventing the Release of Radioactive Materials Remaining Upon Cutting of Pipeways or Tanks

Japanese Patent 59,102,199/A/ (1984, June 13)

The purpose of the procedure is to prevent the release of radioactive material remaining upon cutting of pipeways or tanks. The method used is as follows: a small diameter bore is opened in the wall of a pipeway or a tank incorporating radioactive materials. A resin solution or electrostatic resin powder is sprayed through the hole to coat the entire inner surface of the pipeway or the tank with the resin. The resin coating may be applied either by spraying the resin solution or depositing the chargeable resin powder. By inserting a jetting port from the hole in the pipeway or the tank, since the inner surface of the pipeway or the tank is coated during or after the cutting, release of the radioactive material can be prevented.

255

Scharnhorst, N.L., G.H. Bryan, and W.J. Bjorklund, Pacific Northwest Laboratory, Richland, WA

Remote Removal of Contaminated Equipment from a Radiochemical Engineering Cell

PNL-SA-12393; CONF-841105; Nuclear Power - A Global Reality, Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (p. 468); Transactions of the American Nuclear Society 47:468 (1984, October)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING DISMANTLEMENT AND DEMOLITION

Safe remote removal of radioactively contaminated equipment was performed at the Pacific Northwest Laboratory (PNL) during the cleanup of a hot cell containing equipment used to demonstrate the vitrification of high-level waste. The equipment had to be cut into pieces that could be packed into shielded boxes for disposal. Innovative adaptations were made to state-of-the-art cutting tools to make this safe handling and disposal possible within the physical restraints of a radioactive cell.

256

Shinoda, M., T. Nagase, Y. Shimazaki, and S. Kosuge, Shimizu Construction Company, Limited, Tokyo, Japan

Method of Disposing Nuclear Power Plant

Japanese Patent 78,71,799/A/; 4 pp. (1976, December 7)

A method is described for disposing of a nuclear power plant by burying it underground without taking it outside the containment building. Mortars are filled in the core of a nuclear power plant after removal of the fuel rods and coolant for fixing the inside of the core and shielding remaining radiation. Various plugs are fixed by welding or bolting and plug holes are filled with lead. A containment shell is then formed with concrete just beneath the core. After cutting off the parts connected to the reactor, the reactor is suspended by a jack and, after the removal of a floor, deposited within the containment shell. Mortars or other similar materials are charged to the periphery of the reactor to complete the burying work. Disposal of the power reactor can thus be attained without breaking up the core and with no radioactive exposure to workers during disposal work and with relatively easy handling after the disposition. (PTO)

257

Woollam, P.B., Central Electricity Generating Board, Berkeley Nuclear Laboratories, Berkeley, United Kingdom

Five Years of European Research into Decommissioning

Nuclear Engineering International 29(358):15-18 (1984, August)

In 1979 the European Community started a first five-year program of research into the decommissioning of nuclear power plants. Having completed this program, the Commission organized a conference in Luxembourg in May with the primary objective of presenting and discussing the results obtained. The generally accepted definitions of the stages of decommissioning are: (1) stage 1 decommissioning relates to the period immediately following final shutdown of the nuclear power plant, when the reactor is defuelled and made safe, the work essentially being an extension of normal operations; (2) stage 2 decommissioning has the objective of dismantling all of the plant external to the biological shield; and (3) stage 3 is the removal of the reactor itself together with its biological shield, or pre-stressed concrete vessel, and final clearance of the site rendering it safe for further use. This is potentially the most difficult stage because of the activated fixed reactor structure which might demand the use, at least in the short term, of specialized remote systems. It is, therefore, the most expensive part of the whole task, the cost depending on the time-scales involved. (JWF)

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Wyman, V.

Demolition for the Nuclear Age

Engineer 259(6712):58-60 (1984, November 15)

Procedures for the standardization of nuclear waste canisters are discussed. In the event of a large decommissioning program for nuclear reactors, it will be imperative that methods for the disposal of the contaminated components be found. Methods and equipment for the dismantling of reactors are discussed.

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Yie, G.G. Institute of Gas Technology, Energy Distribution Research, Chicago, IL

Water Jetting - A New Way To Fracture Concrete and Rock

Pipe Line Industry 49(4):49-52 (1978, October)

An experimental high-pressure pulsed-water-jet system has been developed and tested at the Institute of Gas Technology for fracturing concrete pavement. Test results have shown that such a system can be a quieter and more efficient way of fracturing concrete than other methods and may even have greater applications in mining, rock fracturing, boring and underwater excavations. (JWF)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING SITE STABILIZATION AND RECLAMATION

260

Dunaway, P.B., and E.R. Sorom, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV

Cleanup Trial in the NTS Plutonium Valley

Transactions of the American Nuclear Society 43:56-57; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 56-57) (1982)

The purpose of this trial was to develop a technique to reduce costs of decontaminating areas where radionuclides are deposited on or near soil surfaces. Nuclear weapons testing, other operations, and various accidents caused deposition of radionuclides on soil surfaces in earlier years, and remedial actions for such contamination can be expensive, particularly with respect to packaging, transport, and disposal. In addition, a potential for accidental surficial contamination still exists. Previously used decontamination techniques usually resulted in removal of excessive amounts of soil, much of it uncontaminated. Such techniques can result in unreasonable costs and environmental damage. A cleanup and treatment (CAT) trial was conducted in Plutonium Valley at the Nevada Test Site (NTS) in 1981. Two experimental plots were laid out near 'Site C' which is contaminated with relatively high levels of Pu-239, Pu-240, and Am-241. Vegetation and small vertebrate surveys were done, after which the areas were devegetated with minimum disturbance. Soil samples were taken to ascertain surface and profile concentrations, Pu/Am ratios, and particle sizes with which the radionuclides were associated. In situ surveys were performed with a mobile vehicle prior to the first soil removal run and after each run.

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Timmerman, C.L., Pacific Northwest Laboratory, Richland, WA

Stabilization of Contaminated Soils by In Situ Vitrification

CONF-8403105; Proceedings of the 13th Annual Environmental Systems Symposium, Bethesda, MD, March 20, 1984; (13 pp.) (1984)

In Situ Vitrification is an emerging technology developed by Pacific Northwest Laboratory for potential in-place immobilization of radioactive wastes. The contaminated soil is stabilized and converted to an inert glass form. This conversion is accomplished by inserting electrodes in the soil and establishing an electric current between the electrodes. The electrical energy causes a joule heating effect that melts the soil during processing Any contaminants released from the melt are collected and routed to an off-gas treatment system. A stable and durable glass block is produced which chemically and physically encapsulates any residual waste components. In situ vitrification has been developed for the potential application to radioactive wastes, specifically, contaminated soil sites; however, it could possibly be applied to hazardous chemical and buried munitions waste sites. The technology has been developed and demonstrated to date through a series of 21 engineering-scale tests [producing 50 to 1000 kg (100 to 2000 lb) blocks] and seven pilot-scale tests [producing 9000 kg (20,000 lb) blocks], the most recent of which illustrated treatment of actual radioactively contaminated soil. Testing with some organic materials has shown relatively complete thermal destruction and incineration. Further experiments have documented the insensitivity of in situ vitrification to soil characteristics such as fusion temperature, specific heat, thermal conductivity, electrical resistivity, and moisture content. Soil inclusions such as metals, cements, ceramics, and combustibles normally present only minor process limitations. Costs for hazardous waste applications are estimated to be less than 175/cu m (5. 00/cu ft) of material vitrified. For many applications, in situ vitrification can provide a cost-effective alternative to other disposal options.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING WASTE DISPOSAL

262

Bergman, C., National Institute of Radiation Protection, Stockholm, Sweden

Classification of Scrap Material from Nuclear Power Plants as Acceptable for Recirculation

A-83-13; 7 pp. (1983, June 22)

During normal maintenance work at power plants large quantities of valuable scrap material are sometimes generated, e.g. when tubings in steam-generators are exchanged. For the utility there is an economic interest on limiting the amount of waste that must be treated as "radioactive waste". By setting limits below which the scrap material can be reused it is possible to gain the value of the scrap material and avoid expensive treatment and disposal of radioactive waste. The Swedish National Institute of Radiation Protection has in a principal decision accepted the reuse of scrap material that contains or may contain small amounts of radioactive material. This document is an English translation of the background material for the Board meeting decision and gives some guidelines for the authority when dealing with this question. (Auth)(CAC)

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Clark, M.J., G.M. Smith, C.R. Hemming, and A.M. Chapuis, National Radiological Protection Board, Chilton, Didcot, Oxfordshire, United Kingdom; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, France

Methodology for Evaluating Radiological Consequences of the Management of Very Low-Level Solid Waste

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 90-103) (1984)

A radiological assessment has been made of the management options for waste materials containing very low levels of radioactivity arising from the decommissioning of a pressurized water reactor (PWR). Estimates have been made of the masses of the materials activated and contaminated to within three limits of the specific activity, 0.37, 3.7, and 37 Bq/g, at three times after reactor shutdown, 5 years, 25 years, and 100 years. The disposal options considered are shallow land burial, at a municipal landfill site or at the reactor site, and disposal on the seabed in coastal waters or the deep ocean. It is assumed that there is no special treatment to reduce or eliminate the potential radiological hazard. Consideration has also been given to the recycling of contaminated steel. The radiological impacts of all the management options for the wastes considered were found to be small. It may therefore be acceptable to allow such very low-level wastes to be disposed of without special restrictions provided that the level and type of activity of the wastes can be verified. (Auth)

264

Huber, B., Commission of the European Communities, Brussels, Belgium

European Community's Research and Development Activities on the Management of Radioactive Waste from Decommissioning

IAEA-CN-43/153; STI/PUB-649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 2, 538 pp.; (pp. 497-505) (1984)

The Commission of the European Communities is conducting an R and D program on the decommissioning of nuclear power plants. The activities carried out within this framework that concern, in particular, management of the radioactive waste arising from the decommissioning are outlined. Characterization of the radioactivity inventory of nuclear power plants at the end of their useful life is of fundamental importance in this context. Research in this field comprises analyses of the trace elements in reactor materials which are relevant for the formation of long-lived radionuclides by neutron activation, as well as examinations of samples taken from activated and contaminated plant components. Most of the radioactive plant components are only surface contaminated. Highly efficient decontamination techniques are being developed with the objective of achieving conditions permitting unrestricted release of the material treated. Other activities concern the conditioning of steel and concrete waste for disposal, and the management of graphite waste from gas-cooled reactors. Large containers are being developed for transport and disposal of radioactive components. Finally, the methods of radiological evaluation and measurement are being studied which are required to decide whether material from the dismantling of nuclear power plants has to be disposed of as radioactive waste or not.

265

Lehman, J., U.S. Department of the Navy, Washington, DC

National Environmental Policy Act Record of Decision for Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants

Federal Register 49(236):47649-47650 (1984, December 6)

This Record of Decision has been prepared on the proposed disposal of decommissioned, defueled naval submarine reactor plants, pursuant to the Council on Environmental Quality Regulations (40 CFR Part 1505) implementing the procedural provisions of the National Environmental Policy Act (NEPA). The Navy has decided to dispose of these reactor plants by land burial at U.S. Department of Energy (DOE) burial sites. In accordance with the Council on Environmental Quality regulations (40 CFR Part 1501), the U.S. Department of the Navy served as the lead agency for preparation of the Environmental Impact Statement (EIS) on this subject. The U.S. Department of Energy (DOE) participated as a cooperating agency with regard to the alternative of land disposal at DOE burial sites. (JWF)

266

Lunning, W.H., United Kingdom Atomic Energy Authority, Risley Nuclear Power Development Establishment, Risley, Warrington, United Kingdom

Economics of Final Decommissioning and Disposal of Nuclear Power Plant

Economics of Nuclear Energy, L.G. Brookes and H. Motamen (eds.). Imperial College of Science and Technology, London, England, Chapman and Hall, London, England; (pp. 303-313) (1984)

The subject is covered under the headings: introduction; decommissioning options; radioactive inventory; WAGR activation and contamination; decommissioning practice; decommissioning wastes and disposal; costs and timescales; conclusion.

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Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, Accident, Three Mile Island Nuclear Station, Unit 2, Pennsylvania-Docket 50-320: Draft Supplement to Final Environmental Impact Statement of March 1981

NUREG-0683 (1983)

The implementation of actions necessary for decontamination of the facility, defueling of the reactor, and disposition of the radioactive wastes that resulted from the accident on March 28, 1979, at Unit 2 of the Three Mile Island Nuclear Station in Dauphin County, Pennsylvania are discussed. The occupational radiation dose and consequent health problems resulting from the cleanup project are reevaluated. Radioactive liquids would be processed to reduce the concentrations of radionuclides. Disposal of large quantities of radioactive water would involve local release into the river after onsite dilution or release into the atmosphere via controlled, forced evaporation. Building and equipment decontamination would involve electrochemical or ultrasonic techniques for equipment and more complex sumping and filtration activities for buildings. Filters and demineralizers would be used in the decontamination of the cooling system. Defueling activities would include inspection of the core, removal of loose debris, and removal of the fuel assemblies. Wastes to be disposed of in off-site areas would be packaged in 55-gallon drums, wooden boxes, and steel containers with capacities as great as 200 cubic feet. Decontamination personnel at the plant would receive a total cumulative radiation dose estimated at 13,000 to 46,000 person-rems for the entire clean-up program, resulting in less than two to six additional cancer deaths among workers and 3 to 12 additional genetic defects. Social impact, as well as economic effects of the project are presented.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING WASTE DISPOSAL

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Price, M.S.T., I. Lafontaine, and K. Pflugrad, United Kingdom Atomic Energy Authority, Atomic Energy Establishment, Winfrith, United Kingdom; Transnubel SA, Dessel, Belgium; Commission of the European Communities, Brussels, Belgium

Large Transport Containers for Decommissioning Waste

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 343-357) (1984)

A study has been made of the types of large transport container which will be needed for bulky radioactive wastes which result from the decommissioning of nuclear power stations. The work was focused on the wastes which arise from light water and gas cooled reactors. Five reference power plants typical of those in the European Community were selected and their associated inventories of neutron activated and contaminated components were assessed. Details of more than 100 existing containers have been compiled and evaluated against a set of generic criteria. The factors affecting transport by road, rail, and waterway, including National Legislation, Codes of Practice, and International Agreements have been examined for their impact on the design of large containers. Transport costs have been estimated using information representative of Belgium and the United Kingdom. The work has led to the formulation of conceptual designs of type B and Low Level Solids/Low Specific Activity containers. Such containers were assumed to be transported from a reactor to a national repository so that the health impact to the public could be assessed. As a result of the study recommendations are made for the next 5-year program of the CEC. (Auth)

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No Place To Go for Decommissioning Waste?

Radioactive Exchange 4(5):3-4 (1985, March 26)

This article briefly discusses the findings of an information paper submitted to the Commission by the staff of the NRC. The paper addresses three main questions: (1) Is there a health and safety problem associated with having licenses with waste material that might not be acceptable at a burial ground? (2) Do all wastes now have a place to go? (3) What is the staff doing to ensure that all wastes have a place to go when a site is decommissioned? (Auth)(CAC)

270

Rainisch, R., and O. Michejda, Burns and Roe Industrial Services Corporation, Paramus, NJ

Transportation of the Reactor Vessel/Internals of Retired Nuclear Power Plants as a Single Package

CONF-830528; PATRAM '83, Packaging and Transportation of Radioactive Materials, Proceedings of the Seventh International Symposium, New Orleans, LA, May 15-20, 1983; (pp. D-II/14-15) (1983)

This paper summarizes a feasibility investigation of removing, transporting and subsequently burying the reactor pressure vessel (RPV) of retired nuclear power plants together with its internals in 'one-piece.' The 'one-piece' alternative is based on removal of the RPV and associated internals as one package, followed by transportation via a single barge shipment to the designated burial site. The decommissioning of retired nuclear power plants is under active consideration throughout the international community, and several power demonstration reactors and research reactors have been retired from active service. However, there is no experience with retiring a present day, large commercial reactor.

271

Schwarzwaelder, R., G. Loercher, C. von Koch, and H. Hepp, NIS Nuklear-Ingenieur-Service GmbH, Hanau, Federal Republic of Germany

Waste Disposal of Reactor Materials from Nuclear Power Plant Modernization and Decommissioning

CONF-830636; Jahrestagung Kerntechnik '83 (Nuclear Technology '83), Proceedings of a Conference,

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING WASTE DISPOSAL

Berlin, Federal Republic of Germany, June 14-16, 1983; (pp. 25-47) (1983, June 14)

The quantity and nature of the steel and concrete masses associated with nuclear power plant modernization and decommissioning are reviewed. Considerations of various disposal paths are shown, and the related aspects of legislation, approval and measurement are examined.

272
Stang, R., W. Steinkilberg, and W. Zimmermann

Disposal of Nuclear Facilities Outlined on the Basis of Prototypical Planning for the Disposal of the FR-2 Reactor Block

Atomwirtschaft, Atomtechnik 29(1):29-31 (1984, January)

The FR-2 research reactor is the oldest German home-made reactor. It was built during the years 1957 to 1961 and is situated in the Karlsruhe Nuclear Research Centre (KfK). On March 7, 1961 it became critical for the first time, reaching a thermal output of 12 MW on December 17, 1962. After an exchange of the fuel elements the output could be raised to 44 MW, which was achieved on June 27, 1966. After approximately 20 operation years the FR-2 was finally shut down on December 21, 1981. The dismantling plan was to remove the reactor block from the plant and to put the reactor building to another use.

273
Takano, M., Ishikawajima-Harima Heavy Industries Company, Limited, Tokyo, Japan

Method of Dismantling and Disposing Nuclear Facility

Japanese Patent 57.175,300/A/; 2 pp. (1982, October 28)

A method is described to reduce the volume of waste resulting from dismantled reactor components, hence reducing the space required for waste disposal. The method involves cutting the components into large pieces in the primary cutting step and then cut into smaller pieces secondary step. The final step consists of crushing the smaller pieces into granules. The granules are subjected to briquetting by pressing or similar processes and then mixed with concrete and molded into a block. (Auth)

274
U.S. Department of the Navy, Washington, DC

Permanent Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants - Availability of Final Environmental Impact Statements

Federal Register 49(108):23109-23110 (1984, June 4)

The U.S. Department of the Navy has prepared a Final Environmental Impact Statement (EIS) to assess the environmental implications of alternatives that could be used to permanently dispose of decommissioned, defueled submarine reactor plants. In accordance with the Council on Environmental Quality regulations for compliance with the National Environmental Policy Act (NEPA) (40 CRF Part 1501), the U.S. Department of the Navy served as the lead agency for preparation of the EIS. The U.S. Department of Energy (DOE) participated as a cooperative agency with regard to the alternative of land disposal at DOE burial sites. By participating as a cooperative agency, DOE obligations under NEPA are fulfilled and no separate DOE EIS is required. With over 100 nuclear-powered submarines in operation, the Navy is faced with the eventual decommissioning of these ships at a future rate of possibly 3 to 4 per year over the next 30 years, and a permanent means of disposal must be developed that is environmentally acceptable. The two basic methods of permanent disposal are land disposal and sea disposal. Impacts assessed for each disposal alternative include expected commitment of resources, land use, transportation requirements, and environmental consequences. The EIS also includes information on the costs of the disposal alternatives. Based on a consideration of all current factors bearing on a disposal action of the kind contemplated, the Navy's preferred alternative at this time is to dispose of the reactor compartments by land burial. (JWF)

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U.S. Department of the Navy, Washington, DC

Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants: Draft Environmental Impact Statement

Report; 436 pp. (1983)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING WASTE DISPOSAL

Disposal of decommissioned, defueled reactor plants from Navy submarines is proposed. Approval of one of the options would allow for safe disposal of decommissioned nuclear submarines through the end of the 20th century. Land disposal would require considerably less space than sea disposal; while the former option would displace only 10 acres, the latter would involve 100 square miles. Sea disposal would also involve the loss of salvageable metal of the submarine hull; approximately 3000 tons of metal would be lost for each submarine disposed of at sea. Sea disposal would disturb the ocean floor and associated habitat in the immediate disposal area. Under either option, slight amounts of radioactivity would be released into the biosphere.

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White, I.F., G.M. Smith, L.J. Saunders, C.J. Kaye, T.J. Martin, G.H. Clarke, and M.W. Wakerly, National Radiological Protection Board, Chilton, Didcot, Oxfordshire, United Kingdom

Assessment of Management Modes for Graphite from Reactor Decommissioning

EUR-9232; 119 pp. (1984)

A technological and radiological assessment was made of the management options for irradiated graphite wastes from the decommissioning of Magnox and AGR. Detailed radionuclide inventories were established. The main contribution is from radioactivation of the graphite and its stable impurities. Three different packaging methods for graphite are described for either sea or land disposal, which are logistically feasible at reasonable cost. Leaching tests were carried out on small samples of irradiated graphite under a variety of conditions including those of the deep ocean bed; the different conditions had little effect on the observed leach rates of radionuclides. Radiological assessments were made of four generic options for disposal of packaged graphite: on the deep ocean bed, in deep geological repositories at two different types of site, and by shallow land burial. Incineration of graphite was also considered, although this option presents logistical problems. With appropriate precautions during the lifetime of the Co-60 content of the graphite, any of the options considered could give acceptably low doses to individuals, and all would merit further investigation in site-specific contexts.

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White, I.F., G.M. Smith, L.J. Saunders, C.J. Kaye, T.J. Martin, and A.N. Knowles, National Radiological Protection Board, Chilton, Didcot, Oxfordshire, United Kingdom; Central Electricity Generating Board, Generation, Development, and Construction Division, Gloucester, United Kingdom; United Kingdom Atomic Energy Authority, Risley Nuclear Power Development Establishment, Risley, Warrington, United Kingdom

Management and Disposal of Graphite Waste

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 327-342) (1984)

A technological and radiological assessment has been made of the management options for irradiated graphite wastes from the decommissioning of Magnox and Advanced Gas-cooled Reactors. The main contribution to the radionuclide inventory of irradiated graphite is from activation of the graphite and its stable impurities. Three different packaging methods for graphite have been described; each could be used for either sea or land disposal, and each is logistically feasible and could be achieved at reasonable cost. Leaching tests have been carried out on irradiated graphite, under a variety of conditions including those of the deep ocean bed; the different conditions had little effect on the observed leach rates of radiologically significant radionuclides. Radiological assessments were made of four generic options for disposal of packaged graphite: on the deep ocean bed, in deep geologic repositories at two different types of site, and by shallow land burial. Incineration of graphite was also considered, though this option presents logistical problems additional to those of direct disposal. With appropriate precautions during the lifetime of the Co-60 content of the graphite, any of the options considered could give acceptably low doses to individuals, and all the options would merit further investigation in site-specific contexts. (Auth)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING REMEDIAL ACTION EXPERIENCE

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Bacca, J.P., Argonne National Laboratory, Idaho Falls, ID

Decontamination of the Argon Cell of the Idaho Fuel Cycle Facility

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. R1 - R16) (1980, October)

The Hot Fuel Examination Facility/South, formerly called the Fuel Cycle Facility, is a large hot-cell facility immediately adjacent to the EBR-II power plant. This facility is comprised of an air-atmosphere hot cell and an argon-atmosphere hot cell. The argon cell was used for the remote pyrometallurgical reprocessing and refabrication of uranium fission metal driver fuel for the EBR-II. The major radioactive contamination in the argon cell is believed to have resulted from the pyrometallurgical reprocessing furnaces and operations which allowed the oxides of the fuel to move around the hot cell as carried by the recirculating argon gas stream. The decontamination process started with the remote removal of the reprocessing, fabrication, and examination equipment, followed by subjecting the cell to dry methods of decontamination and then remote wet decontamination activities. Personnel safety involved careful planning, training, the use of protective clothing, and carrying personal dosimeters. The contact decontamination of the hot cell is described in detail. (ARE)

279

Bicker, A.E., Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV

Decontamination at the Nevada Test Site

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. Z1 - Z4) (1980, October)

The Nevada Test Site is devoted in large part to the testing of nuclear explosive devices. A result of sample recovery and other experimental work is the radioactive contamination of facilities and equipment. During the years of peak activity, experimental reactors were operated and subsequently disassembled for examination. The contamination from fission and activation products was considerable, and periodic decontamination of facilities and equipment was required. This paper discusses personnel control and decontamination agents and techniques that may be relevant to other decontamination efforts. (Auth)

280

Broothaerts, J., E. Detilleux, L. Geens, W. Hild, R. Reynders, J. Baumann, O. Berners, H. Modreker, W. Bretag, W. Pfeifer, and R. Strohmenger, European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium; Kraftanlagen AG, Heidelberg, Federal Republic of Germany; Transnuklear GmbH, Hanau, Federal Republic of Germany

Industrial Experience Gained in the Decontamination of Process Cells, the Dismantling of Process Equipment and the Conditioning of Special Solid Wastes in a Shut-Down Reprocessing Plant

ETR-298; 24 pp. (1979, January)

At the end of the chemical rinsing and decontamination of the shut-down reprocessing plant a detailed program was undertaken for further decontaminations and interventions, serving as a basis for either modification of the plant in view of its eventual restart or for complete dismantling of the installation. This paper gives a presentation of some of the essential works executed and the results obtained during the first phase of this program, including the partial or total dismantling of process equipment like dissolvers and a multi-purpose evaporator. Operations executed for the decontamination of various process cells and a storage pond for high-level solid wastes, after emptying and repacking its contents, are described. The procedure applied for the evacuation of 18 vessels of some 10 cu m of boron glass Raschig rings used as heterogeneous neutron poison is presented together with the conditioning of these rings into waste packages suited for sea disposal. In addition, the compaction and cutting-up of activated fuel element structures and other disused material, stored under water, and the segregation and conditioning of the resulting scrap are reported. The works executed for the decontamination and dismantling of the analytical laboratory of the reprocessing plant are presented. (Auth) (JWF)

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Collins, J.H., and J.W. Logie, Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada

Canadian Decontamination Experience

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. P1 - P21) (1980, October)

After a problem occurred with the NRX Reactor, which is a 30 megawatt, heavy-water-moderated, light-water-cooled, engineering test reactor, the following considerations proved beneficial in several other decontamination activities: (1) planners should always search for the inherently safest procedure, (2) deviations from authorized procedures must have leader approval, (3) careful training on the entire operation should be done before embarking on any phase, (4) a large non-nuclear body of personnel is required to spread the radiation load and to ensure that trained staff do not receive exposures that would prevent them from carrying out tasks requiring their expertise, (5) special tooling requirements should be identified early in the planning phase and testing done before actual use, (6) awareness of the slightly increased background radiation levels that occurs during these kinds of operations, (7) continued review of progress and written documentation is valuable, and (8) use of a mobile personnel decontamination center. (ARE)

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Commission of the European Communities, Directorate-General, Science, Research and Development, Luxembourg, Luxembourg

The Commission's Research Action Programme on the Development of Nuclear Fission Energy

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 6-14) (1984)

For its "framework program 1984-1987" the Commission has defined the major goals for a European Scientific and Technical Strategy. One of the means to reduce the energy dependence of the Community, which is an important objective, is to favor the development of nuclear fission energy. As electricity production by nuclear reactors has reached industrial maturity, the community activities are directed mainly to safety aspects, in order to insure the protection of the workers and the general public, against hazards linked to the operations in the nuclear fuel cycle. A description of the main features of the five sub-programs on nuclear fission is given in the program; these programs are: (1) reactor safety, (2) nuclear fuels and actinides research, (3) management of radioactive waste, (4) safeguarding and management of fissile materials, (5) decommissioning of nuclear installations. The research and development work is carried out either by the Commission's Joint Research Center, or by organizations and companies of the Member countries, with the Commission's financial support. (Auth)

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Commission of the European Communities, Directorate-General, Science, Research and Development, Luxembourg, Luxembourg

The Community's Research and Development Programme on Decommissioning of Nuclear Power Plants - Fourth Annual Progress Report (Year 1983)

EUR-9677 (1985)

This fourth annual progress report of the European Community's program of research on the decommissioning of nuclear power plants contains the 1983 progress results of the projects promoted by the program. For a majority of the 51 research contracts composing the 1979-1983 program, work was completed by the end of 1983. Conclusions drawn from this work are included in the report. The projects concern the following subjects: (1) long-term integrity of buildings and systems; (2) decontamination for decommissioning purposes; (3) dismantling techniques; (4) treatment of specific waste materials - steel, concrete and graphite; (5) large transport containers for radioactive waste produced in the dismantling of nuclear power plants; (6) estimation of the quantities of radioactive waste arising from the decommissioning of nuclear power plants in the community; and (7) influence of nuclear power plant design features on decommissioning. (DCM)

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Cregut, A., and B. Vigreux, Societe Generale pour les Techniques Nouvelles, Saint-Quentin-en-Yvelines, France

French Experience in Decommissioning

CONF-05788; Conference Summaries, Canadian Nuclear Society 4th Annual Conference, Montreal, Quebec, Canada, June 15, 1983, 170 pp.; (p. 147) (1983, June 15)

The authors describe experience in various decommissioning processes and some of the research and testing being done in France.

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Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Reactor Decommissioning Technology Development Program

Report (1983)

As approved by the Japan Nuclear Safety Commission, preparatory work for dismantling the Japan Power Demonstration Reactor (JPDR) of Japan Atomic Energy Research Institute (JAERI) has begun. The dismantling of JPDR was decided when the Japan Atomic Energy Commission established the Long-Term Nuclear Energy Development and Utilization Program in 1982. This report contains charts, graphs, and pictures of the different phases of the program. (CAC)

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Kroeger, J., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Experience in Decommissioning, Illustrated by Selected Examples

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 64-74) (1983, January 26)

The disassembly of active system components was accomplished with mechanical separation methods. Thermal separation methods came into question only in exceptional cases. In general, the required shielding was provided by appropriate filling of the container or by additional shielding with plates of rolled or cast lead obtained during disassembly. The heat exchangers shielded by cast steel casings with flanged closures could only be put into the containers after being disassembled. The shielding required for the transport and storage of the RPV with shield tank was accomplished by using material available on board. The decontamination measures and the release procedure were rendered difficult due to the layout of a great part of the large shieldings in the region of the service room and waste water tank shieldings.

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Kroeger, J., H.K.J. Lettnin, K. Schmidt, U. Birkhold, and J. Obst, GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Decommissioning of the Nuclear Merchant Ship OTTO HAHN

GKSS-83/E/55; 58 pp. (1983)

The NS Otto Hahn is the first nuclear merchant ship in the world to be decommissioned. A description is given of the radiological status of the reactor and technical data collected during the decommissioning process. Licensing and release procedures including radiation measurements taken before and after the decommissioning tasks were performed are presented. Total waste mass generated and curie content are given. The decommissioning work was completed in June 1982 and the ship was released for reuse.

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Lewis, W.H., Nuclear Fuel Services, West Valley, NY

Decontamination Experience at West Valley, New York

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. V1 - V17) (1980, October)

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The West Valley plant was the first industrial reprocessing plant built in the United States. The plant produced uranyl nitrate and plutonium nitrate solutions. Waste was concentrated and stored as a neutralized waste solution. Planning a decontamination program is the most important part of decontamination because it generally takes more time to plan a good program that it does to do the work. The next item to consider is the decontamination methodology to be used. Another important part of the program is the selection of decontaminating reagents. Equipment removal and packaging should be considered in the planning program. It is also necessary to provide a plan for determining progress on a timely basis, which includes the types of monitoring and sampling techniques that will be needed. The clean up of the Fuel Storage Pool and the decontamination of the solvent extraction areas of the plant to permit personnel entry for major equipment modifications are briefly described. (ARE)

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Mallory, C.W., Hittman Nuclear and Development Corporation, MD

Decommissioning of Low-Level Radioactive Waste Disposal Sites: Implications for Future Sites

CONF-820303; Waste Management '82: Waste Isolation in the U.S. and Elsewhere, Technical Programs, and Public Communication, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, March 8-11, 1982, Vol. 1, 612 pp.; (pp. 473-281) (1982)

Three of the six commercial radioactive waste disposal sites in the U.S. have been closed since 1975. The conditions that led to the closure of two of these sites are examined, and remedial actions being initiated at one site to permit decommissioning are surveyed. The West Valley, New York, and Maxey Flats, Kentucky, sites were closed because of stormwater infiltration, vertical migration of radioactive water, and other factors. At Maxey Flats, water is being pumped from the trenches, trench subsidence has been corrected, and trench covers have been improved to increase runoff. Lessons to be learned from experience at this site are discussed, and criteria for planning and decommissioning sites in the future are summarized.

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Manion, W.J., Atomic Industrial Forum, Inc., Washington, DC

Statement of William J. Manion, President, NES Division, Nuclear Energy Services, Inc., Representing the Atomic Industrial Forum

Nuclear Power Costs (Part 1): Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-fifth Congress, First Session, September 12, 13, 14, and 19, 1977, 980 pp; (pp. 424-442) (1977)

Manion outlined the major findings of a recently published Atomic Industrial Forum funded study on the decommissioning of commercial nuclear reactors. The work, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives," required more than a year to complete, and involved the participation of 14 industry representatives who served on a forum task force established to oversee the investigation. (JWF)

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Meyers, G.W., and W.D. Kittinger, Rockwell International, Energy Systems Group, Canoga Park, CA

Progress Report on Decommissioning of the Sodium Reactor Experiment

Transactions of the American Nuclear Society 30:553-554; CONF-7811109; CONF-781105; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 12-16, 1978, 530 pp.; (pp. 553-554) (1978, November)

The disposition mode selected for the last stage of the decommissioning of the sodium reactor experiment (SRE) at the Energy Systems Group's Engineering Field Laboratory near Los Angeles, California, was complete dismantlement. The primary objective is to remove all significant reactor-originated radioactive materials from the site. This final phase of the project began in 1975 with development work for accomplishing remote, underwater cutting of reactor vessels and components. The project will be concluded in FY 1979. This project is the major effort in a DOE-funded program of decommissioning eight nuclear facilities at the field laboratory (SSFL).

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The major tasks that have been accomplished are: (1) Safe removal of radioactively contaminated sodium; cleaning of sodium residues from the reactor vessel, piping, and components; and the reaction of bulk sodium and residues to status permissible for disposal; (2) Safe and controlled removal of very large and heavy, activated or interior contaminated equipment; (3) Removal of reactor vessel internals such as cooling piping, clamps, bellows, and grid plate in a radiologically safe manner; (4) Removal of the five concentric activated and contaminated structures of the reactor vessel; and (5) Removal of the 4-ft-thick biological shielding, storage, and wash cells, hot fuel examination cell, other ground vaults. Activities that remain are those to accomplish final structure decontamination, removal of air cleaning and other support facilities, site repairs, final radiation surveys, and completion of the final report. (Auth)

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Moriyama, N., H. Matsuzuru, and S. Dojiri, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

Decommissioning of Aqueous Homogeneous Critical Facility (AHCF)

JAERI-M-9932; 63 pp. (1982, February)

The Aqueous Homogeneous Critical Facility (AHCF), constructed to investigate the characteristics of a heavy water moderated homogeneous reactor, reached criticality in 1961. The license for the operation of the facility was revoked on December 25, 1962; the facility was mothballed safely. It was determined to remove and dismantle this critical facility at this time in order to obtain information on decommissioning a nuclear power reactor and to release the area for more effective use. This paper describes the program and methods for this decommissioning work, the amount of wastes generated, treatment of nuclear fuel, removal of the fuel handling facility, and radiation protection and safety during this work. (EST)

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Nemec, J.F., UNC Nuclear Industries, Inc., Richland, WA

Statement of Joseph F. Nemec, Program Manager, Standby and Retired Facilities, United Nuclear Industries, Inc.

Nuclear Power Costs (Part 1): Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-fifth Congress, First Session, September 12, 13, 14, and 19, 1977, 980 pp; (pp. 443-454) (1977)

Decommissioning is defined as those actions, taken after a nuclear facility's operational period is concluded, which provide long-term protection to the public and the environment from residual radioactivity contained in the facility. The selection of a particular decommissioning action is dependent on several factors including the type and quantities of radioactive material involved, the future use of the facility and site, facility location, ongoing activities at the site, and cost. (JWF)

294

Obst, J., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Decommissioning of NS Otto Hahn: The Practical Side

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 48-53) (1983, January 26)

The shut-down activities were divided in 4 stages. After the preliminary work, the loops, systems and components were disassembled and packed. Then followed the evacuation of the RPV with shield tank and the decontamination of the ship and its components. Documentation of the movement of all materials and accompanying activities is included.

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Parrish, A.L., Virginia Electric and Power Company, Richmond, VA

Decontamination Experience at the Surry Plant

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. Y1 - Y10) (1980, October)

Surry Plant is located at Hog Island, Surry County, Virginia. It is a 2-unit, 822 MW, 3-loop, Westinghouse NSSS Power with common auxiliary and T/G Buildings. The project consists of four phases: (1) shutdown and preparatory activities, (2) removal activities, (3) installation activities, and (4) post- installation and startup activities. The paper describes the initial decontamiration of reactor containment, shielding of the reactor containment, and personnel protection and decontamination of R/C piping. (Auth)

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Perrigo, L.D., Pacific Northwest Laboratory, Richland, WA

PRTR Rupture Loop Decontamination

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. U1 - U3) (1980, October)

A situation encountered in 1965 in the operation of the Plutonium Recycle Test Reactor (PRTR) is described when UO2-PuO2 rupture debris was removed from the rupture loop. The following lessons were learned: (1) different types of operations and people are required for decontamination as operation shifts from power generation to chemical processing; (2) meticulous planning and training are vital as is good communication; (3) thorough records should be kept so that the factors that lead to successes and difficulties can be quickly identified and exploited or avoided; and (4) remote TV monitors are an excellent means for following operations inside containment. (ARE)

297

Pettit, P.J., Atomic Industrial Forum, Inc., Washington, DC

International Decontamination Experience

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. Q1 - Q11) (1980, October)

The use of chemicals to remove the activated corrosion products from the primary systems of water-cooled reactors is discussed. One of the systems decontaminated using this process was the Douglas Point reactor. For the decontamination, special temporary, high-flow, high-capacity purification equipment was used. This equipment was prepared in advance and installed just after the reactor was shut down. Gentilly-1 was another of the systems decontaminated and presented a special problem: potential sedimentation in low-flow areas of the steam drum of high activity particles of corrosion product released from the fuel cladding. (ARE)

298

Rohner, M., Philadelphia Electric Company, Philadelphia, PA

Decontamination Experience at Peach Bottom

GEND-002; CONF-7911104; Facility Decontamination Technology, Proceedings of a Workshop, Hershey, PA, November 27-29, 1979; (pp. X1 - X61) (1980, October)

This presentation is a distillation of two papers. The first, "Peach Bottom 2 & 3 Regenerative Heat Exchangers, Chemical Decontamination and Seal Ring Repair," details the background and history leading up to the chemical decontamination and installation of seal rings into the shell to channel joints of six reactor water clean-up regenerative heat exchangers located in Units 2 and 3 at the Peach Bottom Atomic Power Station. The topics presented include a description of (1) the reactor water clean-up system, (2) sealing the generative heat exchangers with furmanite, (2) the installation of a bypass, (4) seal ring design, (5) radiation exposure analysis, and (6) seal ring installation details. The second paper, "Peach Bottom 2 & 3 Regenerative Heat Exchangers, Chemical Decontamination and Solidification" by Gregory Casey, Dow Nuclear, describes the chemical decontamination of the regenerative heat exchangers. The purpose of the decontamination was to reduce the radiation levels associated with subsequent heat exchanger repairs. The chemical decontamination removed 10.6 curies of radioactive material at Peach Bottom 3 and 6.3 curies at Peach Bottom 2. Radioactive waste generated by decontamination that could not be treated by existing facilities was successfully solidified by the Dow Solidification process. The chemical decontamination proved to be a very cost-effective method of radiation reduction. (ARE)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING REMEDIAL ACTION EXPERIENCE

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Schafstall, H.G., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

NS Otto Hahn

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 8-16) (1983, January 26)

The advanced PWR chosen for the bulk cargo ship is characterized by an integrated primary loop with automatic pressurization. Altogether the Otto Hahn covered over half a million sea-miles. In-service inspections and examinations of the reactor plant were carried out by control authorities every year. During the whole operating period the NS Otto Hahn showed a safe and reliable behavior, even regarding radiation protection.

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Schafstall. H.G., and K. Schmidt, GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Colloquium on the Decommissioning of the NS Otto Hahn

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp. (1983, January 26)

After successful conclusion of the decommissioning of NS Otto Hahn during the summer of 1982, a specialists meeting was organized by GKSS-Forschungszentrum Geesthacht GmbH in order to present information about planning, procedures used, and experience resulting from the decommissioning process. The state-of-the-art decommissioning techniques, as used for this first German nuclear powered merchant ship, are shown by experts from licensing authorities, the decommissioning company and the ship operator.

301

Taylor, J.M., and V.F. FitzPatrick, Pacific Northwest Laboratory, Richland, WA

Experience in Shipping a Radioactively Contaminated PWR Steam Generator by Ocean Barge

PNL-SA-8041; CONF-801115; PATRAM '80, Packaging and Transporting Radioactive Material, Proceedings of the Sixth International Symposium Berlin, Federal Republic of Germany, November 10, 1980; (7 pp.) (1980)

The shipment of a portion of a contaminated, pressurized water reactor (PWR) steam generator from Surry, Virginia, to Richland, Washington, is described. The shipment of the 200 metric ton steam generator was a first-of-a-kind shipment; prior to this shipment, no contaminated steam generator had ever been removed from a power station site. The generator was removed from operation because of defects and was transported by ocean barge approximately 11,000 kilometers from its point of origin to its final destination. (ARE)

302

Watzel, G.V.P., Rheinisch-Westfalisches Elecktrizitatswerk AG, Essen, Federal Republic of Germany

Shutdown of Nuclear Power Stations as Seen by the Operators

CONF-8104240; Power Plants and Environment, Proceedings of the VGB Conference, Essen, Federal Republic of Germany, April 7, 1981; (pp. 198-203) (1981)

According to the German Nuclear Power Law, shut-down of nuclear power plants requires licensing the same as construction. The subordinate official regulations (safety criteria of the Federal Ministry of the Interior, RSK - Reactor Safety Commission Guidelines) require a formal concept for shut-down, including possible removal, which considers the necessary radiation protection measures. This concept is required on application for the construction license. As a result of these shut-down obligations it is necessary to make certain financial allowances, proof of which also has to be supplied with technical justification. Using Brunsbuettel and Biblis as examples, German utilities carried out a basic study of the formal shut-down plans. This study shows in detail the technical feasibility of a total removal with the technology available today, the structuring of the various activities, their classification in a flow-chart, personnel

requirements, process time, expected radiation exposure and costs. This lecture presents the most important results of this study. The lecture concludes with a short survey of the shut-down experience in Germany in nuclear installations, especially in nuclear power stations.

303

Watzel, G.V.P., I. Auler, B. Broecker, G. Thalmann, and J. Vollradt, Rheinisch-Westfalisches Elecktrizitatswerk AG, Essen, Federal Republic of Germany

Decommissioning of Nuclear Power Plants in the Federal Republic of Germany at End of Useful Life

Duesseldorf, FRG:VDI-Verlag; 94 pp. (1982)

This survey gives the essential results of an investigation on decommissioning and total dismantling of nuclear power plants with LWR-type reactors, concerning technical feasibility and anticipated cost, considering as examples Biblis-A (1204 MW, PWR-type reactor) and Brunsbuettel (805 MW, BWR-type reactor). Considerations included immediate reactor dismantling as well as dismantling after 30 years of permanently secured locking-up. An enumeration of procedures available today is followed by a classification of all work required into distinct work sections, including a detailed description of the procedure by means of a schedule. Personnel required, anticipated radiation exposure and cost are described. Finally, the influence of the ultimate storage conception of critical values for radioactive material and of other marginal conditions on results of the investigation are discussed.

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Willoughby, W., and H.T. Babb, Carolinas Virginia Nuclear Power Associates, Inc., Columbia, SC

CVTR

Nuclear News 13(6):48-51 (1970, June)

The Carolinas Virginia Tube Reactor (CVTR), a 65-MW(t), D2O-cooled and moderated pressure tube reactor, was built and operated under the third round proposal for power demonstration reactors. The experimental program for CVTR was completed in the spring of 1967 after approximately four years of operation. Upon the completion of the test program, the decision was made to terminate operation of the reactor and decommission it. The basic plan for decommissioning, whereby the reactor was deactivated and dismantled to the extent that it no longer exists as a reactor and radioactive materials and equipment are stored within a double security area, protects the public and is more economical than other methods considered. Since there was little dismantling of the primary system, and all core components could be handled and stored using the normal tools and fixtures, there was minimum exposure to the plant personnel during decommissioning. (Auth)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

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Allibert, M., and F. Delabbaye, Commission of the European Communities, Luxembourg, Luxembourg

Cobalt Extraction from Stainless Steels

EUR-8966; 22 pp. (1984)

Dismantling nuclear power plants leads to the need to solve the problem of eliminating highly active cobalt coming from stainless steels. The present study has been carried out in two different ways: ESR (Electro Slag Refining) process application and controlled oxidation with slags. The first one had been given up because of laboratory results confirming thermodynamic calculation according to which cobalt phosphides (the only compound more stable than nickel or iron phosphides), were not soluble enough in slags to be of any interest. The second one, which consisted of melting stainless steel with slags under a controlled oxidation, did not lead to conclusive results because the chemical reaction rate was too low. Based on these studies, a project study of an industrial waste treatment plant has been conducted.

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JPDR Decommissioning Program

Atoms in Japan 29(3):10-18 (1983, March)

As approved by the Japan Nuclear Safety Commission, the preparatory work for dismantling the Japan Power Demonstration Reactor of Japan Atomic Energy Research Institute has begun. As decided in the long term nuclear energy development and utilization program in June, 1982, by the Japan Atomic Energy Commission, the dismantling of the JPDR through its entire phase is the model case for the development of dismantling technology and for the establishment of safety standards in the dismantling of shut-off nuclear power plants and their removal. The schedule of the JPDR dismantling is divided into two phases. In Phase 1, the development of dismantling techniques is made by the end of fiscal 1985; and in Phase 2, the full scale dismantling work is carried out by the end of fiscal 1989. The removal of the related facilities and the rearrangement of the evacuated land also are scheduled to be completed. During the first 10 days of April 1983, the JPDR will be in the sealed-up condition for the purpose of developing the dismantling techniques, and the nuclear fuel has been transferred to the spent fuel pool. National policy on reactor decommissioning and the program for technology development are reported.

307

Auler, I., and G. Loercher, NIS Nuklear-Ingenieur-Service GmbH, Hanau, Federal Republic of Germany

Nuclear Power Plant Decommissioning

Atomwirtschaft, Atomtechnik 29(11):567-568 (1984, November)

During the decommissioning of nuclear facilities, the radioactivity of the various systems and components calls for particular attention and special methods in order to prevent harmful effects on the environment. Such methods and strategies have been developed and tested for years now. They refer to radiation protection, the handling and dismantling of large-size radioactive components, the decontamination of component parts and systems, and to the safe transport and storage of radioactive materials. National efforts in this field have been accompanied for the last five years by activities sponsored by a research program of the Commission of European Communities, the results of which were discussed at the conference.

308

Baumann, B.L., UNC Nuclear Industries, Inc., Richland, WA

Evaluation of Nuclear Facility Decommissioning Projects Program - Status

UNI-SA-132; CONF-8410142; Proceedings of the 12th Water Reactor Safety Research Information Meeting, Gaithersburg, MD, October 23, 1984; (8 pp.) (1984, September 20)

In recent years major studies have been undertaken by the U.S. Nuclear Regulatory Commission (NRC) and others concerning the technology, safety, and costs associated with decommissioning nuclear facilities. The Evaluation of Nuclear Facility Decommissioning Projects (ENFDP) program described in this presentation is being undertaken by the NRC to compile and evaluate the activities of ongoing decommissioning projects. Assessment and evaluation of the methods, impacts, radiation exposure, and costs will provide a basis for evaluating licensee's decommissioning proposals and for future decommissioning direction and regulation. Program participants include the U.S. Nuclear Regulatory

Commission (NRC) through the Office of Regulatory Research, UNC Nuclear Industries (UNC) through the Decommissioning Programs Department, and nuclear facility licenses. A computerized data collection system has been developed to store and manipulate relevant data from the nuclear facility decommissioning projects in this study. The decommissioning information includes but is not limited to: costs for labor, waste disposal and shipping; radiation exposure and facility dose rates; volume and curie content of generated waste; and lessons learned. This presentation reviews the progress of the program with emphasis on projects not yet completed. These are Humboldt Bay Unit 3, the Shippingport Atomic Power Station Decommissioning and the Three Mile Island Unit 2 recovery efforts.

309

Bernhardt, D.E., P.J. MacBeth, A.A. Sutherland, M.W. Grant, G.M. Sandquist, and M.L. Mauch, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Radioactive Contamination at Federally Owned Facilities

RAE-23-1; 343 pp. (1982, June)

Federally-controlled facilities that are contaminated with radioactivity are listed and described. Estimates of current levels of contamination are provided and decontamination and decommissioning (D&D) procedures are discussed. All of this information has been gathered from available literature and personal contacts with individuals; no new measurements or site visits were made. Finally, estimates of amounts and activities of low-level and transuranic wastes that can be generated from D&D of federally controlled facilities are provided. (Auth)

310

Bluemle, J., Kernforschungszentrum Karlsruhe GmbH, Hauptabteilung Kerntechnische Betriebe, Karlsruhe, Federal Republic of Germany

Report on the Operation in 1981 of the FR2 Research and Testing Reactor

KFK-3383-B; 92 pp. (1983, September)

The outstanding event in 1981, the last year of FR2 operation, was the final shutdown of the reactor on December 21, 1981. It brought to an end a 20 years period of successful reactor operation and experimentation. The FR2 was the first nuclear reactor to be planned, designed and built in Germany. It had been conceived as a universal-purpose reactor and thus allowed to perform beam tube experiments, to irradiate reactor materials and nuclear fuels, and to produce radioactive isotopes. During the period of reporting the net capacity factor of the reactor attained 91% in the scheduled period of power operation. An average power of 43.9 MW led to a thermal energy production of 8868 MW-days. The development of the experimental utilization of the FR2 reflected the forth-coming decommissioning of the reactor. After two beam tube experiments had been transferred to external reactors, 20 experiments of this type were still pursued which, however, were very intensively exploited till the very last day of operation, inclusive of the cold neutron source and the low-temperature irradiation rig. Isotope production rose to an unexpectedly high level. The number of the instrumented capsule test rigs and the utilization of the gamma-irradiation rig remained unchanged compared with the preceding year.

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Canfield, M., Jr., U.S. General Accounting Office, Washington, DC

Statement of Monte Canfield, Jr., Director, Energy and Minerals Division, U.S. General Accounting Office

Nuclear Power Costs (Part 1): Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-fifth Congress, First Session, September 12, 13, 14, and 19, 1977, 980 pp; (pp. 406-423) (1977)

Canfield's statement noted that protecting the public from the hazards of radiation lingering at inactive nuclear facilities is a problem which needs federal attention, if a strategy for finding a solution is to be developed. A strategy to clean up these privately and federally owned nuclear facilities, which continue to accumulate, cannot be developed until basic questions on the magnitude of the problem, such as costs, radioactivity, and timing, have been answered. (JWF)

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Commission of the European Communities, Luxembourg, Luxembourg

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Community's Research and Development Programme on Decommissioning of Nuclear Power Plants: Second Annual Progress Report (Year 1981)

PB-83-241562; 78 pp. (1981)

The progress and results of seven projects undertaken in 1981 are reported and guidelines having some bearing on decommissioning practices available in CEC Member States are examined.

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Decommissioning of Nuclear Facilities: Decontamination, Disassembly and Waste Management

CONF-8204153; Techniques for Decontamination and Decommissioning of Nuclear Facilities and the Management of Waste from Decontamination and Decommissioning Activities, Proceedings of a Technical Committee Meeting, Vienna, April 19-23, 1982, 79 pp. (1983)

The term 'decommissioning', as used within the nuclear industry, means the actions taken at the end of a facility's useful life to retire the facility from service in a manner that provides adequate protection for the health and safety of the decommissioning workers, the general public, and for the environment. These actions can range from merely closing down the facility and a minimal removal of radioactive material coupled with continuing maintenance and surveillance, to a complete removal of residual radioactivity in excess of levels acceptable for unrestricted use of the facility and its site. This latter condition, unrestricted use, is the ultimate goal of all decommissioning actions at retired nuclear facilities. The purpose of this report is to provide an information base on the considerations important to decommissioning, the methods available for decontamination and disassembly of a nuclear facility, the management of the resulting radioactive wastes, and the areas of decommissioning methodology where improvements might be made. Specific sections are devoted to each of these topics, and conclusions are presented concerning the present status of each topic. A summary of past decommissioning experience in Member States is presented in the Appendix. The report, with its discussions of necessary considerations, available operational methods, and waste management practices, together with supporting references, provides an appreciation of the activities that comprise decommissioning of nuclear facilities. It is anticipated that the information presented in the report should prove useful to persons concerned with the development of plans for the decommissioning of retired nuclear facilities.

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Denys, C.J., Illinois Legislative Council, Springfield, IL

Decommissioning Nuclear Power Plants - Memo File

PB-84-160936; 49 pp. (1983, October)

Three approaches to decommissioning are considered: permanent entombment, safe storage, and dismantlement. The cost of decommissioning is addressed, and it is noted that approximately 33 percent of the cost is for shipment and disposal of radioactive materials while only about 19 percent is for demolition of the remaining contaminated structure. Financing options are summarized, including deposit method, unfunded reserve, and general tax revenues. It is concluded that because Illinois has the largest nuclear power capacity of any state and because it has the oldest privately built commercial nuclear power plant in the country, its state government should act to get the federal government to expedite promulgation of the desired standards, regulations, and guidelines for decommissioning.

315

Doerge, D.H., and R.L. Miller, UNC Nuclear Industries, Inc., Richland, WA

Evaluation of Nuclear Facility Decommissioning Projects: Summary Report - Three Mile Island Unit 2 Polar Crane Recovery

NUREG/CR-3884; 63 pp. (1984, August)

This document summarizes information concerning restoration of the Three Mile Island-Unit 2 Polar Crane to a fully operational condition following the loss of coolant accident experienced on March 28, 1979. The data collected from activity reports, reactor containment entry records and other sources were placed in a computerized information retrieval/manipulation system. This system permits extraction/manipulation of specific data which could be utilized in planning for recovery activities should a similar accident occur in a nuclear generating plant. The information is presented in both computer output form and a manually assembled summarization. This report contains only manpower requirements and radiation exposures actually incurred during recovery operations within the reactor containment and does not include support activities or costs.

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Elder, H.K., Pacific Northwest Laboratory, Richland, WA

The Effect of Accidents on Decommissioning Waste Management for Nuclear-Fuel Cycle and Nonfuel Cycle Facilities

Transactions of the American Nuclear Society 44:148-149 (1983)

Decommissioning of a nuclear facility is required at the end of its operational life to assure the protection of public health and safety from residual radioactivity. Preliminary results of a study sponsored by the U.S. Nuclear Regulatory Commission are summarized. The study conceptually evaluated post-accident cleanup and decommissioning of nuclear fuel cycle and nonfuel cycle facilities. Decommissioning waste management following an accident is compared with waste management considerations after normal shutdown for reference mixed-oxide (MOX) and uranium fuel fabrication plants and nonfuel cycle facilities. Information from the study is intended for use by the NRC as background data and to form a basis for the modification of existing regulations and the development of new regulations pertaining to decommissioning.

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Tearing Down A-Plants Heats Up

Engineering News-Record 213(17):24-27 (1984, October 25)

Decommissioning of nuclear reactors is discussed. The question of what to do with the damaged reactor at Three Mile Island is forcing the issue. There are many more nuclear power plants sitting in limbo until decisions are made concerning the way in which to dispose of the radioactive scrap from these reactors. The 27-year-old Shippingport reactor is the leading candidate for demolition. Plans are to start dismantling the reactor in 1985.

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Fukushima, A., Agency of Natural Resources and Energy, Tokyo, Japan

Decommissioning of Nuclear Power Plant

Karyoku Genshiryoku Hatsuden 33(7):693-698 (1982, July)

Nuclear power generation is the most promising and realistic substitute energy for petroleum, and its development and utilization must be promoted positively to secure the stable supply of energy. The oldest nuclear power station in Japan is about 15 years old now, and its final disposal is not an urgent problem for the time being. However, when nuclear power generation is promoted, the measures taken for safely and smoothly carrying out the treatment and disposal of decommissioned nuclear power stations must be thoroughly investigated. It is considered that the decommissioning of nuclear power plants can be basically dealt with by the present techniques, but it is important to make its safety more perfect, and also to utilize the sites for new nuclear power stations. The Reactor Decommissioning Investigation Committee was established in the Agency of Natural Resources and Energy, and the investigation is carried out. The mechanical lifetime of nuclear reactors is considered to be 30 to 40 years. The methods of decommissioning are mothballing, entombment and dismantling. The state of investigation on the countermeasures to the decommissioning, the safety, the economy and the treatment and disposal of wastes is reported.

319

Report of Expert Committee on Nuclear Reactor Decommissioning Countermeasures: On Decommissioning of Nuclear Reactors

Genshiryoku Iinkai Geppo 27(3):15-20 (1982, June)

This is a report of the titled committee dated March 16, 1982, submitted to the chairman of atomic energy commission of Japan. The contents are roughly divided into two parts: the fundamental philosophy on the decommissioning of nuclear reactors, and the promotion of measures for reactor decommissioning. In the former, the importance of decommissioning measures for large scale power reactors are described, because the dismantling of

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

nuclear facilities performed in the past includes only those for small scale research reactors. The decommissioning options for nuclear reactors include: (1) mothballing, (2) inplace entombment, and (3) the removal of radioactive components and dismantling. The fundamental policy for these stages has been established. Methods the promotion of decommissioning measures, the improvement of dismantling and associated techniques, the securing of safety, and the establishment of financial measures are reported. In addition, nuclear waste countermeasures and the consolidation of various systems are needed. The measures will be promoted by sectioning the period into Phase 1 (first half of 1980's), Phase 2 (second half of 1980's) and Phase 3 (first half of 1990's) to be prepared for the expected permanent termination of power reactor operation to be started in the second half of the 1990's.

320
Gortz, R., H. Bastek, W. Dorge, and K.P. Kruschel, Bundesminister des Innern, Bonn, Federal Republic of Germany

A Study of the Decommissioning of Nuclear Facilities

BMI-1985-065; 139 pp. (1985, February)

The study discusses and evaluates safety and licensing aspects associated with the decommissioning of nuclear power plants. Important decommissioning projects and experiences with relevance to decommissioning are analyzed. Recent developments in the field of decommissioning techniques with the potential of reducing the occupational dose to decommissioning workers are described and their range of application is discussed. The radiological consequences of the recycling of scrap metal arising during decommissioning are assessed. The results may be used to evaluate present licensing practices and may be useful for future licensing procedures. Finally the environmental impact of radionuclide release via air and water pathways associated with decommissioning activities is estimated. (Auth)

321
Holter, G.M., and E.S. Murphy, Pacific Northwest Laboratory, Richland, WA

Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station: Classification of Decommissioning Wastes

NUREG/CR-0130 (Add. 3) (1983)

The radioactive wastes expected to result from decommissioning of the reference pressurized water reactor power station are reviewed and classified in accordance with 10 CFR 61. The 17,885 cubic meters of waste from DECON are classified as follows: Class A, 98.0%; Class B, 1.2%; Class C, 0.1%. About 0.7% (133 cubic meters) of the waste would be generally unacceptable for disposal using near-surface disposal methods.

322
House, K.E.

Scrapping the Atom: U.S. Is Facing Problem of How To Dismantle Used Nuclear Reactors

Wall Street Journal, October 12, 1977 (1977, October)

This newspaper article discusses decommissioning alternatives such as mothballing, entombment, and dismantling. Opinions of Nuclear Regulatory Commission staff, the General Accounting Office and Congress are cited. Reference is made to the decommissioning of the Sodium Reactor Experiment in Santa Susana, California. (ARE)

323
Huber, B., Commission of the European Communities, Brussels, Belgium

The European Community's Programme of Research on the Decommissioning of Nuclear Power Plants: Objectives, Scope and Implementation

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp.; (pp. 22-32) (1984)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

The European Community's research project activities on the decommissioning of nuclear installations are aimed at developing effective techniques and procedures for ensuring the protection of man and his environment against the potential hazards from nuclear installations that have been withdrawn from service. The first five-year (1979-1983) program of research on the decommissioning of nuclear power plants has comprised seven R&D projects concerning the following areas: (1) maintaining surplus plants in a safe condition, (2) surface decontamination for decommissioning purposes, (3) dismantling techniques, (4) treatment of the main waste materials arising from decommissioning, (5) large containers for decommissioning waste, (6) sources and characteristics of decommissioning waste, (7) plant design features facilitating decommissioning. The research work was carried out by organizations and companies in the Member States under 51 research contracts, most of them cost-sharing. The Commission is now beginning a new five-year (1984-1988) program of research on the decommissioning of nuclear installations. (Auth)

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Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, Federal Republic of Germany

Development of Methods and Techniques for the Decommissioning and Ultimate Disposal of Nuclear Facilities

KFK-2435; Second Semiannual Report for 1976; (pp. 492-495) (1977, April)

The research activities reported include: (1) dismantlement and demolition of steel and concrete including large components and auxiliary systems; (2) transportation of nuclear reactor components; (3) waste treatment; (4) schedule for decommissioning activities; (5) special arrangement of reactor components; and (6) new reactor lines. (Auth)(PTO)

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Kyriazis, W.J., and R.A. Paasch, UNC Nuclear Industries, Inc., Richland, WA

Compendium on Decommissioning Activities in NEA Member Countries

Report; 121 pp. (1985, January)

The Nuclear Energy Agency (NEA) Radioactive Waste Management Committee of the Organization for Economic Cooperation and Development (OECD) is an international committee composed of senior government experts in this field. In the specific area of decommissioning of nuclear installations, the committee has, in the last few years, directed an active program including exchange of information, preparation of technical reports, and the promotion of international cooperative projects. During the years 1981-1984, the committee sponsored an inquiry on the status of decommissioning projects in member countries and the needs of technology exchange in this field, based on two questionnaires issued in November 1981 and in November 1983. This report contains information provided by a number of OECD/NEA Member countries and international agencies in response to the above mentioned questionnaires, and was prepared with the support of the U.S. Department of Energy, by UNC Nuclear Industries on behalf of the NEA Radioactive Waste Management Committee. (Auth)(JWF)

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Lawton, H., United Kingdom Atomic Energy Authority, Windscale Nuclear Power Development Laboratories, Seascale, United Kingdom

Reactor Decommissioning

Nuclear Engineering Journal, Institute of Nuclear Engineering 25(5):191-192 (1984, September-October)

This article discusses decommissioning of nuclear facilities, which is a growing facet of the industry, and one which will become much more important in the next 25 years. The UKAEA has decided to develop the new techniques required in decommissioning, particularly of reactors, by carrying out a pioneering project on the Windscale Advanced Gas-cooled Reactor (WAGR), the small-scale prototype of the WAGRs now used by the Electricity Boards.

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Lee, K., University of Washington, Seattle, WA

Radioactive Waste

Nuclear Almanac: Confronting the Atom in War and Peace, J. Dennis (ed.). Addison-Wesley Publishing Company, Reading, MA, 564 pp.; (pp. 259-280) (1984)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

The author surveys radioactive wastes, mainly in the United States, both by source and type, including a look at the implications of decommissioning nuclear facilities. The checkered history of waste storage and planning is also examined, in a search for institutional lessons relevant to handling the large and increasing volume of wastes contaminated with radioactive isotopes.

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Bibliography of Published Work 1962-1982 and Addendum

London: Nuclear Installations Inspectorate (1983)

This bibliography contains references to published reports, conference papers, and journal articles produced by individual members of the Nuclear Installations Inspectorate and the Inspectorate as a body. It covers the years of 1962-1982. The 112 titles cover such topics as: reactors (AGR, FBR, Gas cooled, PWR, SGHWR); nuclear power plants (commissioning, construction, decommissioning, inspection, licensing, operation, safety, siting); accidents; radioactive waste; pressure vessels; nuclear fuel plants; legislation; regulation; Nuclear Installations Inspectorate organization; and risk assessment. An appendix listing seven reports relating to the Sizewell B PWR public inquiry published in 1983 has been included.

329
McLaren, L.H., U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, TN

Decontamination and Decommissioning

DOE/TIC-3391 (Suppl. 1); 82 pp. (1985, February)

This bibliography contains information on decontamination and decommissioning included in the U.S. Department of Energy's Energy Data Base from November 1982 through December 1983. The abstracts are grouped by subject category as shown in the table of contents. Entries in the subject index also facilitate access by subject. Within each category the arrangement is by report number for reports, followed by nonreports in reverse chronological order. These citations are to research reports, journal articles, books, patents, theses, and conference papers from worldwide sources. Five indexes, each preceded by a brief description, are provided: Corporate Author, Personal Author, Subject, Contract Number, and Report Number. (JWF)

330
Mehrgardt, H., GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Federal Republic of Germany

Monitoring of the Decommissioning Work

GKSS-83/E/69; CONF-830178; Colloquium on the Decommissioning of the NS Otto Hahn, Geesthacht, Federal Republic of Germany, January 26, 1983, 72 pp.; (pp. 48-53) (1983, January 26)

The task of the TUeV-Norddeutschland was limited to radiation protection. Apart from the evaluation of radiation protection, simultaneous control with evaluation of the measuring procedures was achieved. The complete shut-down of the plant has been entirely documented.

331
Miller, R.L., B.L. Baumann, and D.H. Doerge, UNC Nuclear Industries, Inc., Richland, WA

Evaluation of Nuclear Facility Decommissioning Projects - Annual Summary Report, Fiscal Year 1984

NUREG/CR-4090; 122 pp. (1985, January)

This document summarizes work performed during the 1984 fiscal year for the U.S. Nuclear Regulatory Commission's Evaluation of Nuclear Facility Decommissioning Projects program. This report describes actual work performed during the reporting period and work planned for the future. Included as an appendix to this report is a draft of the current data from the TMI-2 recovery efforts and Shippingport Atomic Power Station decommissioning.

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Nedderman, J.M.

Decommissioning a PWR

Nuclear Engineering International 24(4):104-106 (1983, July)

The author discusses briefly current experience and proposals for the dismantling of a PWR.

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

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Decommissioning of Nuclear Power Plants

Nuclear News 27(9):125-128, 133 (1984, July)

The Conference on Decommissioning of Nuclear Power Plants, to report on the Commission of the European Communities' (CEC) first five-year program of research, showed that the projects supported by that program have yielded a great deal of relevant technical knowledge and have also demonstrated a degree of international information exchange that is remarkable. Topics covered at the conference include overall decommissioning strategy, CEC research work, unrestricted release of a decommissioned facility, decontamination techniques, dismantling techniques, remote operations, and waste treatment. (ARE)

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Pacific Northwest Laboratory, Richland, WA

Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station: Classification of Decommissioning Wastes

NUREG/CR-0672 (Add. 2) (1984)

The radioactive wastes expected to result from decommissioning of the reference boiling water reactor power station are reviewed and classified in accordance with 10 CFR 61. The 18,949 cubic meters of waste from DECON are classified as follows: Class A, 97.5%; Class B, 2.0%; and Class C, 0.3%. About 0.2% (47 cubic meters) of the waste would be generally unacceptable for disposal using near-surface disposal methods.

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Saddington, K., United Kingdom Atomic Energy Authority, Windscale Laboratory, Seascale, United Kingdom

Decommissioning of Nuclear Facilities

Nuclear Power Technology, Volume 2 - Fuel Cycle, W. Marshall (ed.). Clarendon Press, Oxford, United Kingdom; (pp. 335-367) (1983)

The disposal of obsolete nuclear facilities, generally termed decommissioning, is a requirement which will grow with the world-wide expansion of nuclear energy programs. It is therefore attracting increasing international attention. After all fissile material has been removed from the plant, several options exist to dispose of the remaining plant and buildings. As a minimum the plant may be closed down, made safe, and left intact on a "care and maintenance" basis. At the other extreme, all plant buildings may be demolished and removed from the site. After any necessary clean-up is completed, the site is then available for unconditional reuse. The factors which govern the option selected are identified along with the consequences which stem from the decision. Technical aspects are discussed under the headings of decontamination, demolition, and disposal. Other aspects include costs and safety requirements. The current status of decommissioning is outlined in terms of practical experience, paper studies, and present legislation. The need for further information in all of these areas is recognized. Nevertheless, the conclusion is reached that the decommissioning of redundant nuclear plants can be safely accomplished, even to the cleared-site condition. (Auth)(PTO)(DCM)

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Savchenko, V.A., and S.N. Skovorod'ko

Nuclear Power Plant Decommissioning

Atomnaya Tekhnika za Rubezhom 10:16-20 (1983)

Technical characteristics and factors pertaining to nuclear power plant reactor decommissioning developed by the IAEA expert working group are considered. The experience in the solution of this problem in the U.S., main trends and plans of the WAGR reactor decommissioning in the United Kingdom, technological developments in the Federal Republic of Germany and Japan are discussed. Activity and mass formed in the process of decommissioning of radioactive wastes are shown. There are more than 60 reactors that are at the decommissioning stage. In the U.S., 20 power reactors are to be decommissioned by 2000, 50 by 2005, and 70 by 2010.

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Schaller, K., and B. Huber, Commission of the European Communities, Brussels, Belgium

Decommissioning of Nuclear Power Plants

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

EUR-9474; CONF-840524; Decommissioning of Nuclear Power Plants, K.H. Schaller and B. Huber (eds.), Proceedings of a Commission of the European Communities Conference, Luxembourg, Luxembourg, May 22-24, 1984. Graham and Trotman Limited, London, United Kingdom, 461 pp. (1984)

The prime objective of the research program, sponsored by the Commission of European Communities, on the decommissioning of nuclear power plants is to develop effective techniques and procedures for ensuring the protection of man and his environment against the potential hazards from shutdown nuclear power plants. The Commission of the European Communities organized this international conference to present the results achieved during the past five years of the program. It also provided an opportunity for discussion among experts from Member States of the European Community and participating scientists from outside the Community on issues and options for future research. The conference was limited to invited papers, presented by scientists involved in European Community contract studies. The topics covered by the conference and in the proceedings included: (1) characterization of the radioactivity associated with nuclear power plants that have been finally shut down; (2) implications of maintaining shut-down nuclear power plants for long periods before dismantling, (3) decontamination of metal and concrete surfaces for decommissioning purposes; (4) dismantling of nuclear power plant components and structures; (5) conditioning and packaging of the radioactive waste arising from the dismantling; (6) systems for remotely controlled decommissioning operations; (7) aspects related to the classification of solid decommissioning waste, namely measurement of very low-level radioactivity and evaluation of radiological consequences; (8) nuclear power plant design features facilitating decommissioning; and (9) experience with industrial-scale decommissioning operation. The proceedings also report the discussions on the papers as well as the results of two technical panels and of the concluding panel. (JWF)

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Smith, C.V., Jr., U.S. Nuclear Regulatory Commission, Washington, DC

Statement of Dr. Clifford V. Smith, Jr., Director, Office of Nuclear Materials Safety and Safeguards, Nuclear Regulatory Commission

Nuclear Power Costs (Part 1): Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-fifth Congress, First Session, September 12, 13, 14, and 19, 1977, 980 pp; (pp. 304-405) (1977)

Smith's statement summarized the present NRC practices in the decommissioning of nuclear facilities, described studies that are underway to refine and improve the decommissioning process, and explained funding arrangements for decommissioning. He also submitted a written statement that included additional details of present practices in the decommissioning of reactors and fuel cycle facilities and the history of decommissioning and the NRC regulatory authority. (JWF)

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The Institute of Applied Energy, Tokyo, Japan

Decommissioning in Japan

Report (1983)

In Japan, 24 commercial power reactors are in operation and the total amount of electric power of the reactors is about 17,000 MW(e). The oldest of these reactors was built in 1966. Since the operation life of the reactors is considered to be about 30 years, it is necessary to build up technologies for decommissioning of the reactors before the year 2000. Studies on policy, technology and cost for decommissioning of nuclear power plants have been prompted by governmental and private organizations. The AEC of Japan established the basic policy for decommissioning on March 16, 1982. The Japan Power Demonstration Reactor, JPDR, constructed in 1963, has been determined to be the test facility of nuclear reactors by AEC, and Japan Atomic Energy Research Institute has been investigating the technologies and cost for decommissioning of JPDR under the sponsorship of The Science and Technology Agency, STA, since 1981. The Institute of Applied Energy has been studying technologies, regulations and costs for decommissioning since 1979, under sponsorship of the Ministry of International Trade and Industry (MITI). The results of the study are to be utilized to decide the policy on decommissioning. A project of assurance tests of dismantling technologies has started under the sponsorship of MITI, since 1981. This report gives a summary of the current status of decontamination technology in Japan, current status and future trend of concrete demolition techniques in Japan, and a description of the current decommissioning program in Japan. (Auth)(CAC)

CHAPTER 2. NUCLEAR FACILITIES DECOMMISSIONING GENERAL STUDIES

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Torigai, K., University of Tokyo, College of Science and Technology, Tokyo, Japan

Decommissioning of Nuclear Reactors, 1: Introduction

Genshiryoku Kogyo 31(2):71-76 (1985)

Various aspects of decommissioning of nuclear reactors are reviewed. Topics included in the discussion are: (1) methods used in decommissioning; (2) the present status of nuclear reactor decommissioning; (3) evaluation of *radioactivity inventory; (4) planning and implementa*tion of plans for decommissioning; and (5) dismantling waste.

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U.S. Congress, House of Representatives, Committee on Armed Services, Procurement and Military Nuclear Systems Subcommittee, Washington, DC

Uranium Ore Residues: Potential Hazards and Disposition

Hearings Before the Procurement and Military Nuclear Systems Subcommittee of the Committee *on Armed Services, United States House of Repre*sentatives, 97th Congress, First Session, June 24-25, 1981; H.A.S.C. No. 97-14 (1981)

After decades of research, important questions remain unanswered about the cancer risks of low-level ionizing radiation exposure. With the increasing use of materials and processes that produce ionizing radiation, it has become more important to resolve these questions. Medical diagnosis and therapy, mining, certain building materials, fallout from nuclear tests, and the nuclear power cycle are among the many sources of ionizing radiation. The hearings were scheduled so that Congress can learn about the adequacy and practicality of the standards developed for decontamination by the regulatory agencies, in addition to how well the U.S. Department of Energy, the States, and the nuclear industry can comply with these standards and at what cost and risk to the public and the national treasury. (Auth)(ARF)

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Wakefield, J.R., United Kingdom Atomic Energy Authority, Windscale Nuclear Power Development Laboratories, Seascale, United Kingdom

WAGR Decommissioning Newsletter - Autumn 1983

WAGR Decommissioning Newsletter 1:1-8 (1983, September 26)

The purpose of this newsletter is to update progress on UKAEA's project to decommission the Windscale Advanced Gas-Cooled Reactor (WAGR). This newsletter contains information on the dismantling progress and development progress. The purpose of this bi-annual newsletter is to promote the distribution of information on the intention and progress of the decommissioning project. The project has been in existence for some years now but progress in the early days was slow. The objectives then were to establish the broad approach in the fields of dismantling techniques and waste disposal. The philosophies that emerged have been maintained through the subsequent periods of accelerated design and development. The basic disposal package is a reinforced concrete container with integral strength and shielding features. The main cutting technique is thermal and the waste handling route is via a heat exchanger biological shield into a purpose-made building. The heat exchangers will each be removed complete by a single lift and laid down alongside the reactor. The packaging envelope of these and the activated core components is suitable for both sea and land disposal; this option has been maintained throughout. The decommissioning exercise has been designated a development led project and is staffed by two interrelated teams. This newsletter contains progress reports by the two teams in their respective fields of activity. The first report addresses the dismantling progress. A brief discussion is given on each of the five stages of dismantling. These stages are: (1) Removal of the fuel from the core; (2) Removal of the four heat exchangers; (3) Establishing the waste disposal route; (4) Segregation and removal of the pressure vessel; and (5) Removal of outer shells, i.e. concrete shields and outer containment envelope. The second report addresses the development progress. Since this will be the first power-producing reactor to be decommissioned in the United Kingdom, there are many important lessons to be learned in taking it apart. These lessons will establish the suitability of different techniques of reactor decommissioning and provide assessments of equipment and human performance. This means that a significant

amount of development work is called for at the early stages of the project to enable decisions to be made on the design of machines and procedures. A program of this work has been drawn up to include the functional testing of equipment and the training of operators. The program will include: flame cutting with metal powder injection; plasma arc cutting; mechanical cutting; remotely operated viewing and highlighting equipment; ventilation and filtering; handling and disposal operations; curie assessment of waste material; experimental evaluation of proposed dismantling procedures; and full-scale providing trials prior to installation of equipment. One aspect of this is discussed in this report, the fume and dust generated by powder/flame cutting. Strachan and Henshaw have been assisting UKAEA with the following problem areas: survey of remote handling proprietary machines/systems; review of alternative cutting processes to gas cutting; development of outline specifications for handling tool packages; and development of design solutions for controlling dust and fumes. (Auth)(CAC)

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Wakefield, J.R., United Kingdom Atomic Energy Authority, Windscale Nuclear Power Development Laboratories, Seascale, United Kingdom

WAGR Decommissioning Newsletter - Winter 1984

WAGR Decommissioning Newsletter 3:1-15 (1984, December 4)

This newsletter is an update of the progress of the United Kingdom Atomic Energy Authority (UKAEA) project to decommission the Windscale Advanced Gas-Cooled Reactor (WAGR). Progress in the following areas is reported: (1) dismantling; (2) design; (3) HERO decommissioning development facility; and (4) risk assessment for waste disposal package transport. The first article presented addresses the changes to the removal and disposal of the four heat exchangers as well as the progress of the Waste Packaging Building and the Turbine Hall. The second article describes the design progress in relation to the Waste Packaging Building and the Decommissioning Machine. The third article gives a brief description of the HERO (ex WAGR zero energy reactor) facility and how it will be used to simulate certain features of WAGR. An article on risk assessment briefly outlines some aspects of risk assessment and is concerned primarily with the accidental exposure of people to radiation. (Auth)(CAC)(DCM)

Chapter 3

FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Final Report on Remedial Action at the Acid/Pueblo Canyon Site, Los Alamos, New Mexico

DOE/OR/20722-15; 37 pp. (1984, October)

The Acid/Pueblo Canyon site (TA-45) was designated in 1976 for remedial action under the Formerly Utilized Sites Remedial Action Program. During the period 1943-64, untreated and treated liquid wastes generated by nuclear weapons research activities at the Los Alamos Scientific laboratory (LASL) were discharged into the two canyons. A survey of the site conducted by LASL in 1976-1977 identified two areas where radiological contamination exceeded criteria levels. The selected remedial action was based on extensive radiological characterization and comprehensive engineering assessments and was comprised of the excavation and disposal of 390 cu yd of contaminated soil and rock. This document describes the background to the remedial action, the parties involved in administering and executing it, the chronology of the work, verification of the adequacy of the remedial action, and the cost incurred. (Auth)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Environmental Monitoring Report for the Former Middlesex Sampling Plant and Middlesex Municipal Landfill Sites, Calendar Year 1983

DOE/OR/20722-17; 45 pp. (1984, October)

During 1983, an environmental monitoring program was continued at the former Middlesex Sampling Plant (MSP) and former Middlesex Municipal Landfill (MML) sites, located in the Borough of Middlesex, New Jersey. The sites are part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy (DOE) program to clean up or otherwise control sites where low-level radioactive contamination remains from the early years of the nation's atomic energy program. The monitoring program at the MSP and MML measures the uranium and radium concentrations in surface and groundwater, the radon concentrations in air, and external gamma exposure levels. Radiation doses to the public are also calculated. All environmental samples collected are analyzed to determine compliance with applicable environmental quality standards. DOE Order 5480.1A, Chapter XI, provides applicable Concentration Guide (CG) limits for radionuclides in controlled and uncontrolled areas. During 1983, average annual concentrations of uranium and radium-226 in groundwater and surface water within the controlled areas of both the MSP and MML were below the DOE CG for uncontrolled areas. Annual average radon levels in air at both the MSP and MML were below the CG for uncontrolled areas. External gamma monitoring in 1983 showed all monitoring locations at both sites reporting gamma exposure rates below DOE Radiation Protection Standards. All radiation doses to the public were within DOE standards. Results of the monitoring program during 1983 did not differ significantly from the results obtained during 1982.

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Preliminary Engineering Evaluation of Remedial Action Alternatives for the Middlesex Municipal Landfill, Middlesex, New Jersey

DOE/OR/20722-19; 120 pp. (1984, August)

This Preliminary Engineering Evaluation of Remedial Action Alternatives considers an engineering evaluation, radiological surveys, environmental monitoring report, geological investigations, DOE cleanup guidelines, and preliminary engineering and chemical characterization work. The remedial action alternatives are based on known radiological and other potentially hazardous (chemical) conditions. While the findings of the chemical characterization could affect the comparison of these alternatives from the standpoint of their respective viability and desirability, the study is expected to be principally informative for operational control purposes, rather than option limiting in light of the known history of the site and its utilization. This document is intended to provide the information needed to support selection of a remedial action to be implemented at the Middlesex Municipal Landfill site. (Auth)

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Radiological Survey Report for the Former Middlesex Sampling Plant

DOE/OR/20722-20; 51 pp. (1985, March)

The former Middlesex Sampling Plant (MSP), Middlesex, New Jersey is currently owned by the United States Department of Energy (DOE). It was used from 1943 to 1967 as a sampling and storage facility for uranium and thorium concentrates. During the course of operations, the buildings and grounds at the site became contaminated. In 1980, DOE initiated a multiphase remedial action project to clean up the site and several vicinity properties onto which contamination from the plant had migrated. Material from these properties was consolidated on a storage pile at the MSP during Phases I and II of the project. A decision by DOE regarding the final disposition of the site will be made once the results of an engineering evaluation of disposition alternatives and of other studies required by the National Environmental Policy Act are available. This report describes the current radiological status of the MSP site as determined by a characterization survey performed to obtain information necessary for the development of the Phase III engineering design. The grounds and the four buildings on-site were surveyed; uranium-238 and radium-226 concentrations exceeded DOE remedial action guidelines. Approximately 69,000 cu m of material must be removed for the site to comply with guidelines. This total comprises the following approximate volumes: 13,000 cu m of asphalt/gravel and soil from the grounds, 3,650 cu m from demolition of the Boiler House and Process Building, and 52,000 cu m of contaminated material that is or will be stored on-site. In addition, parts of the Garage and Administration Building must be decontaminated. (Auth)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Final Report on Phase 2 Remedial Action at the Former Middlesex Sampling Plant and Associated Properties

DOE/OR/20722-27 (Vol. 1); 111 pp. (1985, April)

The former Middlesex Sampling Plant (MSP) and several adjacent and vicinity properties in Middlesex and Piscataway, New Jersey were designated in 1976 for remedial action under the Formerly Utilized Sites Remedial Action Program (FUSRAP). Phase I of the cleanup as well as the engineering and initial construction effort for Phase II were conducted by NLO, Inc. At the start of FY 1982, Project Management Contractor responsibilities were assumed by Bechtel National, Inc. Phase I work comprised the construction of an impervious asphalt storage pad and drainage system at the former MSP site as well as decontamination of two properties adjacent to the site and three properties in the vicinity. Phase II involved cleanup of low-level radioactive waste that had migrated onto other properties adjacent to the site, the construction of an extension to the waste storage pad, and the installation there of a treatment system for rain runoff. All parcels were cleaned to the remedial action criterion level of 5 pCi/g radium-226 plus background specified by DOE. This report describes the background to the Phase II remedial action, the parties involved in administering and executing it, the chronology of the work, verification of the adequacy of the remedial action, and the cost incurred. (Auth)(JWF)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Final Report on Phase 2 Remedial Action at the Former Middlesex Sampling Plant and Associated Properties

DOE/OR/20722-27 (Vol. 2); 105 pp. (1985, April)

Volume two presents the radiological measurements data taken after remedial action on the properties surrounding the former Middlesex Sampling Plant during Phase II of the DOE Middlesex Remedial Action Program. Also included are analyses of the confirmatory radiological survey data for each parcel with respect to the remedial action criteria established by DOE for the Phase II cleanup, and a discussion of the final status of each property. (JWF)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

Final Report on Phase 2 Remedial Action at the Former Middlesex Sampling Plant and Associated Properties

DOE/OR/20722-27 (Vol. 3); 184 pp. (1985, April)

This report contains two appendices. Appendix A outlines the calibration of in situ gamma measurements during Phase II operations. Appendix B consists of 27 tables listing measurements of radiation levels and radium-226 concentrations following remedial actions at the Middlesex site. (JWF)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Radiological Survey of the Albany Research Center, Albany, Oregon

DOE/OR/20722-29; 85 pp. (1985, January)

In early 1984, a radiological survey was conducted at the Albany Research Center (ARC) in Albany, Oregon. The survey was performed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy effort to identify, clean up, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early years of the Nation's atomic energy program. From 1978 through 1982, the Argonne National Laboratory (ANL) conducted radiological surveys of the ARC and identified areas with radiological readings above background. The 1984 survey was necessary to determine actual levels of contamination in each area and to define the locations and boundaries of above-guideline contamination. The survey was conducted by the FUSRAP Program Management Contractor, Bechtel National, Inc., and its radiological subcontractor, Eberline Instrument Corporation. The 1984 survey revealed site field areas with above-guideline concentrations of thorium-232 and radium-226 in surface and subsurface soils. Using the 1984 survey findings for surface area and depths of contamination, and based on current cleanup guidelines for thorium-232 and radium-226, approximately 2000 cu m (2600 cu yd) of contaminated material would require removal for the ARC site to comply with guidelines. Cleanup of approximately 5 cu m (6.5 cu yd) of above guideline contamination in two sumps, one drain, and associated piping also would be required. In addition, nine buildings contained scattered above-guideline contamination on floors and/or walls, in trenches and drains, and on equipment. Decontamination could be accomplished with the removal of approximately 1 cu m (1.3 cu yd) of surface material, plus decontamination of drains, trenches, and equipment as appropriate. (Auth)(JWF)

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Environmental Monitoring Report, 1980, 1981, 1982 for the Former Middlesex Sampling Plant and Middlesex Municipal Landfill Sites

DOE/OR/20722-3; 79 pp. (1984, October)

During periods of remedial action activities conducted in 1980 and 1981 at designated sites in the Borough of Middlesex, New Jersey, air, water, and sediments were sampled and analyzed to verify the adequacy of contamination control and compliance with applicable standards. Analytical results show that remedial action activities at the Middlesex Sampling Plant (MSP) and vicinity properties were conducted, with few exceptions, within applicable standards. During 1982, a surveillance monitoring program was initiated at the MSP and at the former Middlesex Municipal Landfill (MML) site. Radioactivity was measured in air and water to allow calculation of radiation doses to the public. The resulting dose from external gamma radiation at the MSP site boundary in 1982 was approximately twice natural background and less than 40% (background included) of the U.S. Department of Energy (DOE) standard. The highest continuous occupancy dose to the bronchial epithelium (lungs) from radon exposure at the MML boundary was approximately twice the background value or about 60% (background included) of the DOE standard.

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Bechtel National, Inc., Advanced Technology Division, Oak Ridge, TN

Radiological Survey of the Former Shpack Landfill, Norton, Massachusetts

DOE/OR/20722-4; 166 pp. (1984, May)

The distribution of contamination on the Shpack Landfill site is spotty and uneven, both horizontally and vertically. Although some hotspots exceed FUSRAP criteria, average concentrations of soil contamination are below the residual limits requiring remedial action. Removal of the hotspots only would generate approximately 390 cu m of low-level radioactive waste. However, because of the relative physical and chemical stability of the radioactive contamination, such an effort could be deferred without harmful effect to individuals, the public, or the natural environment. The site is also widely contaminated with chemical pollutants that might eventually require remedial action pursuant to several state and federal environmental statutes. The timing and nature of these possible environmental improvements could easily negate the need for a separate remedial action to clean up the radioactive contamination. (Auth)

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Boerner, A.J., Oak Ridge Associated Universities, Oak Ridge, TN

Comprehensive Radiological Survey of the Niagara Falls Storage Site Off-Site Properties, Lewiston, New York

Health Physics 47(1):141; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

At the request of the U.S. Department of Energy, Oak Ridge Associated Universities performed a comprehensive assessment of the radiological conditions on approximately 1300 acres of the formerly utilized MED/AEC Niagara Falls Storage Site (Lake Ontario Ordnance Works) off-site properties, Lewiston, New York. Radiological information collected included direct radiation exposure rates and surface beta-gamma dose rates, locations of contaminated surface residues, concentrations of radionuclides in surface and subsurface soil, in ground water, in surface water and sediment, and surface contamination levels in structures. Ground radar scans were used to identify possible burials and subsurface utilities. The survey identified areas of elevated radiation levels associated with stored residues and surface contamination. Major radionuclides included Ra-226, U-238, Cs-137, and Th-232. Most of the contamination was in small, isolated locations and, in some cases, the elevated levels were contained in crushed rock or chemical-process slag used for fill and as a paving base in the Niagara Falls area. Limited areas of subsurface contamination were also present at several locations of waste storage and burial. This report presents details of the monitoring equipment and procedures utilized in the project. Problems encountered and solutions to these problems are also discussed. (Auth)

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Brewer, S.T., U.S. Department of Energy, Washington, DC

Floodplain Statement of Findings, 1984 Remedial Action at the Hazelwood Interim Storage Site and Vicinity Properties, Hazelwood and Berkeley, Missouri

Federal Register 49(128):27197-27198 (1984, July 2)

The Formerly Utilized Sites Remedial Action Program (FUSRAP), U.S. Department of Energy (DOE), has prepared a floodplain assessment for proposed remedial actions in 1984 at the Hazelwood Interim Storage Site and Vicinity Properties in Hazelwood and Berkeley, Missouri, pursuant to 10 CFR 1022.18. Some of the proposed action will take place within the Coldwater Creek floodplain. Following publication a notice of floodplain involvement (49 FR 22679), DOE prepared a floodplain assessment. Alternatives to the proposed action were identified, environmental impacts evaluated, and mitigating measures identified. Based on the assessment, DOE has determined that there are no practicable alternatives to the proposed remedial action and that it has been designed to minimize potential harm within the floodplain. (JWF)

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Brewer, S.T., U.S. Department of Energy, Washington, DC

Floodplain Involvement Notification for Proposed Remedial Action at Properties Located in Wayne, NJ

Federal Register 49(144):30007 (1984, July 25)

The U.S. Department of Energy proposes to conduct remedial actions involving removal and control of radioactively contaminated material on properties in Wayne, New Jersey, as directed by Congress in the House-Senate Conference Report accompanying the Energy and Water Development Appropriation Act for 1984. Any comments are due on or before August 9, 1984. (JWF)

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Coffman, F.E., U.S. Department of Energy, Washington, DC

Certification of the Radiological Condition of the Former Site of the Radioactive Liquid Waste Treatment Plant (TA-45) and Effluent Receiving Areas of Acid, Pueblo, and Los Alamos Canyons, Los Alamos, NM

Federal Register 49(210):43493 (1984, October 29)

The U.S. Department of Energy has completed radiological surveys of and has taken remedial actions to decontaminate the former site of the radioactive liquid waste treatment plant (TA-45), Los Alamos National Laboratory, Los Alamos, New Mexico. The site contained low levels of radioactive material deposited during the period when the laboratory was operated under contract to the Manhattan Engineer District and the Atomic Energy Commission. The Department has certified that the former TA-45 plant site and associated areas of Acid, Pueblo, and Los Alamos Canyons are in compliance with all applicable decontamination criteria and standards. (JWF)

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Gilbert, T.L., Argonne National Laboratory, Argonne, IL

Radiological Protection Guidelines for the Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 11) (1984, November 6)

The need for a definitive basis for radiological guidelines and criteria for FUSRAP became apparent by 1981 and led ORO to sponsor a joint ANL/BNI/LANL/ORO effort under the chairmanship of Wayne Hansen (LANL) that resulted in a final FUSRAP radiological guidelines document in March 1983. A separate effort to develop guidelines for remedial action criteria for SFMP was in progress at PNL. The need to coordinate both efforts with impending revisions of DOE Radiological Protection Standards and impending new developments in EPA and NRC Radiological Protection Standards led to convening of the first DOE Workshop on Remedial Action Criteria in Gaithersburg, Maryland, in February 1984, followed by a second workshop in June 1984 at ANL. The major decisions were to base the criteria on dosimetry models and basic limits currently recommended by the International Commission on Radiological Protection, to emphasize the development and use of site-specific rather than generic guidelines and criteria for residual radionuclide concentrations in the ground, and to prepare a manual to accompany the guidelines that would present procedures and tables for deriving site-specific soil guidelines and criteria for the remedial action programs. A joint ANL/LANL/ORNL/PNL effort to prepare a definitive set of guidelines and a manual has been initiated. The scope, status, and current plans for this effort, and some of the key issues, are presented.

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Hart, S.S., Stratitek Inc., Lakewood, CO

Organization, Objectives, and Present Status of FUSRAP and UMTRAP

CONF-830744; Environmental Engineering, Proceedings of the 1983 National Conference, Boulder, CO, July 6-8, 1983; (pp. 310-317) (1983)

The rapid growth of the uranium mining, milling, and processing industries in the United States between 1940 and 1970 was primarily due to the need for nuclear-weapons-grade materials by the Manhattan Engineer District and its successor, the Atomic Energy Commission. Hundreds of privately and publicly owned sites utilized in this new industry still contain radioactive mill tailings or processing residues. Due to increasingly stringent radiological standards, Congress authorized the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 and the Uranium Mill Tailings Remedial Action Program (UMTRAP) in 1978.

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

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Hillman, R.E., J.W. Williams, R.A. McGrath, F.I. Saksa, and L.S. Gomez, Battelle New England Marine Research Laboratory, Duxbury, MA

Aquatic Bioassays of FUSRAP Soils

IEEE Oceans '83, Proceedings of a Marine Technology Society and Oceanic Engineering Society Conference, San Francisco, CA, August 29-September 1, 1983, 911 pp.; (p. 6) (1983, August 29 - September 1)

The DOE Formerly Utilized Sites Remedial Action Program (FUSRAP) is designed to assess the feasibility of disposing FUSRAP soil and rubble containing traces of natural radioactive materials in the ocean and on the sea-bed floor. According to EPA criteria, the material must be shown to be non-toxic in 10-day bioassays prior to disposal permit approval. Assays were conducted with FUSRAP soils from a New Jersey site, using clams, shrimp, and sand worms. Routine assays for several heavy metals were also performed. No toxicity in the FUSRAP soil to clams or worms was evident after 10 days.

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Kuhaida, A.J., J.M. Leidle, S.D. Leidle, and P.R. Cotten, Bechtel National, Inc., Oak Ridge, TN

The Development of Environmental Monitoring Programs at Four Formerly Utilized Sites Remedial Action Program (FUSRAP) Sites

CONF-841187; Proceedings of the Fifth DOE E ronmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 26) (1984, November)

Environmental monitoring plans were developed for four FUSRAP sites designated for remedial action funding under the 1984 Energy and Water Appropriations Act. The sites are located in Hazelwood, Missouri; Colonie, New York; and Wayne and Maywood, New Jersey. The primary elements of each environmental monitoring plan, as outlined in Chapter III of DOE Order 5485.1, required monitoring for external radiation and radiological monitoring in air, surface water, sediment, and groundwater on a routine basis. The extent of each monitoring plan in relation to the selection of suitable monitoring methods, parameters, and sample locations was based on factors including historical data describing site operations, radiological and nonradiological waste generation, local, state, and federal governmental concerns; and the extent and type of utilization of affected offsite air, land, and water. The Hazelwood site was formerly used for the drying and storage of radioactive residues from uranium ore handling operations. Both the Maywood and Wayne sites processed thorium ore, while the Colonie site handled enriched uranium fuel elements and depleted uranium. All four sites are located in urban areas. Surface water hydrology is typically complex with indistinct drainage ways and subsurface conduits. Groundwater is present at each of the sites and is a major concern for potential contamination. The monitoring programs include radon and thorium gas levels in the air and surface and sediment sampling for radionuclides characteristic of past activities at each site. Groundwater monitor wells will be installed and used to evaluate the presence of radionuclides beneath the sites. External gamma radiation will be monitored for changes in radiation exposure rates. (Auth)(JWF)

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Levesque, R., BVC Consultants, Inc., Sun City Center, FL

Soil Decontamination

EPRI-NP-3222; CONF-830162; Proceedings of the 1983 American Society of Mechanical Engineers and Electrical Power Research Institute Radwaste Workshop, B.V. Coplan (ed.), Charlotte, NC, January 31, 1983; (pp. 88-91) (1983, August)

This presentation discusses the approaches used by Bechtel National, Inc. (BNI) to decontaminate and/or stabilize contaminated sites under the Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP).

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Miller, C.G., Bechtel National, Inc., Oak Ridge, TN

Site Cleanup Lessons Learned: Formerly Utilized Sites Remedial Action Program (FUSRAP) Government Owned Facility - Niagara Falls

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The Niagara Falls Storage Site is described in detail, as are the current U.S. Department of Energy objectives, management responsibilities, interim remedial actions, contractor responsibilities, work done to date, future work, costs of individual tasks, and observations and lessons learned. Some of the observations and lessons learned are as follows: (1) general contractors can learn to function effectively in a relatively short period of time but special emphasis must be placed on advance notification of working conditions to be encountered; and (2) use of multiple contractors complicates the establishment of an equitable priority system for the use of decontamination facilities. The subcontractor's employees generally appreciate the personnel health/safety programs and are supportive of safety measures taken. Adverse weather conditions have a greater impact on remedial actions in a radiological environment because of the problems caused by water interfering with the radiological measurement instruments. The handling of "construction water" and sediment control is a major time and cost factor in remedial action work. Special attention should be given to the preparation of detailed construction schedules and the correlation of these schedules with the expected "good" summer weather. (ARE)

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Neal, P.E., Bechtel National, Inc., Oak Ridge, TN

Site Cleanup Lessons Learned: Formerly Utilized Sites Remedial Action Program (FUSRAP) - Middlesex Site

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The remedial actions at the Middlesex Site have proven that there is no requirement for breakthroughs in operations and equipment technology. Existing equipment was used in some interesting applications. Several of the lessons learned which may be applicable to future operations were concerned with management and public relations. The importance of establishing certification procedures and report requirements must be stressed in order to assure high quality and well-documented results. Good and frequent contacts with local officials and the land owners are important to keep the job moving and to avoid future legal complications. Great care must be exercised to assure that residential property is not destroyed without proper restoration. Contractors must be controlled and be on schedule. Special conditions may be necessary to keep down the perception of the spread of contamination and to assure that the job flows in the proper order. The use of fixed-price type contracts to perform decontamination work proved to complicate the job and lead to many change orders and legal problems. The remedial actions resulted in moving the contaminated materials from the adjacent and vicinity properties to a proposed stockpile area. At the stockpile area the material is protected and migration prohibited under a controlled monitoring program. Determination of the final disposition of the material has not been made. (Auth)

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Neal, P.E., Bechtel National, Inc., Oak Ridge, TN

Site Cleanup Lessons Learned: Formerly Utilized Sites Remedial Action Program (FUSRAP) - Middlesex Site

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 23) (1984, November)

The Middlesex Site discussed in this paper is the Middlesex Sampling Plant (MSP) property, some properties adjacent to the plant, and some vicinity properties. This site has been designated as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). The steps taken during decontamination and restoration work are described; there is also discussion of special equipment, new techniques, unexpected problems, and lessons learned which might be applicable to future remedial action tasks. The remedial actions resulted in moving the contaminated materials from the adjacent and vicinity properties to an interim stockpile area. At the stockpile area the material is protected and migration prevented under a controlled monitoring program. Determination of the final disposition of the material has not been made. (JWF)

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Oak Ridge National Laboratory, Oak Ridge, TN

Formerly Utilized Sites Remedial Action Program

ORNL/NFW-82/37; ORNL Nuclear Waste Programs Annual Progress Report for Period Ending September 30, 1982; (pp. 309-317) (1983, May)

The concept of in-situ stabilization has been proposed for both the Middlesex, New Jersey Sampling Plant Site and other facilities under FUSRAP. Expressed in the most-simplified manner, this concept envisions utilizing the natural materials (soil, other sediments, bedrock where applicable) at a site to contain the radionuclides present in contaminated material. This can possibly be accomplished by either admixing these natural-earth materials with the wastes or burying the wastes within an envelope provided by the natural materials. In some cases, both admixing and burial can be practiced to assure containment. In a related approach, various substances, either natural, such as bentonite, or artificial, such as ion-exchange resins, can be added to further the containment capabilities of the natural materials available at a given site. Data are summarized on the critical elements of geology and hydrology at the Middlesex site.

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Remedial Action at Hazelwood

Radwaste News 5(13):101 (1984, July 21)

The U.S. Department of Energy is accommodating the wishes of the cities of Hazelwood and Berkeley in Missouri. The Hazelwood site is a storage facility for tailings of uranium and thorium ores. DOE intends to eventually clean up the site as part of its Formerly Utilized Sites Remedial Action Program. The two cities cannot wait until DOE's remedial action program at the Hazelwood site is complete. The situation is further complicated by the fact that some of the remedial actions must be done in a floodplain. DOE has decided to move the contaminated soil from the floodplain area to a storage site pending final cleanup. (Auth)(ARE)

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Schlatter, J.F., Bechtel National, Inc., Oak Ridge, TN

Community Relations Planning for the Formerly Utilized Sites Remedial Action Program

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

Community relations planning is a joint effort between Bechtel and the U.S. Department of Energy. DOE has primary responsibility for communicating policy matters, while Bechtel handles communications related to specific work on the site. The basic objective of the public communications plan are to (1) keep appropriate public officials informed of work activities and involved in the decision-making process, (2) allay public fears through open communications, (3) facilitate orderly completion of remedial action, and (4) comply with the public participation requirements of the National Environmental Policy Act. (Auth)

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Seeley, F.G., and A.D. Kelmers, Oak Ridge National Laboratory, Chemical Technology Division, Oak Ridge, TN

Geochemical Information for Sites Contaminated with Low-Level Radioactive Wastes: 2 - St. Louis Airport Storage Site

ORNL-6097; 63 pp. (1985, January)

The St. Louis Airport Storage Site (SLASS) became radioactively contaminated as a result of wastes that were being stored from operations to recover uranium from pitchblende ores in the 1940s and 1950s. The U.S. Department of Energy is considering various remedial action options for the SLASS under the Formerly Utilized Site Remedial Action Program (FUSRAP). This report describes the results of geochemical investigations at Oak Ridge National Laboratory (ORNL) to support the FUSRAP activities and to aid in quantifying various remedial action options. The investigation at ORNL produced results of two geochemical aspects: (1) characterization of SLASS soils and groundwater, and (2) laboratory measurement of uranium and radium sorption behavior and uranium apparent concentration limit values in SLASS soil/groundwater systems obtained by batch contact methodology. Soil samples from the surface to bedrock were found to be typical silt-clay materials. Illite was the major clay identified by x-ray diffraction analysis. The uranium and radium concentrations were significantly above background near the old contaminate surface horizon (now at the 0.3- to 0.9-m depth); the maximum values were 1566 ug/g and 101 pCi/g, respectively. Below about the 6-m depth, the concentrations appeared to be typical of those naturally present in soils of this area (3.8 plus or minus 1.2 ug/g and 3.1 plus or minus 0.6 pCi/g). Uranium sorption ratios showed stratigraphic trends but were generally moderate to high (100 to 1000 l/kg). The sorption isotherm suggested an apparent uranium concentration limit of about 200 mg/l. This relatively high solubility can probably be correlated with the carbonate content of the soil/groundwater systems; that is, a solubility of this magnitude is assumed to result from formation of the soluble uranyltricarbonate complex. The lower sorption ratio values obtained from the sorption isotherm may have resulted from changes in the experimental procedure or the groundwater used. The SLASS appears to exhibit generally favorable behavior for the retardation of uranium solubilized from waste in the site. Parametric tests were conducted to estimate the sensitivity of uranium sorption and solubility to the pH and carbonate content of the system. The potential of several soil additives for improving uranium retention at the site was explored in a few experiments. The very high sorption ratios (10,000 L/kg) obtained for fly ash from coal combustion indicate that this material could be a possible remedial action candidate. Sorption tests with radium-spiked SLASS well water gave moderately high sorption ratios (800 to 940 L/kg). Thus, the SLASS may also exhibit favorable behavior for retarding radium solubilized from waste emplaced at the site. (Auth)(JWF)

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U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, TN

Formerly Utilized Sites: Remedial Action

DOE/TIC-3392 (Suppl. 1); 40 pp. (1985, April)

This bibliography contains information on formerly utilized sites included in the U.S. Department of Energy's Energy Data Base from November 1982 through December 1983. The abstracts are grouped by subject category. Entries in the subject index also facilitate access by subject. Within each category the arrangement is by report number for reports, followed by nonreports in reverse chronological order. These citations are to research reports, journal reports, journal articles, books, patents, theses, and conference papers from worldwide sources. Five indexes, each preceded by a brief description, are provided: Corporate Author, Personal Author, Subject, Contract Number, and Report Number. (Auth)(CAC)

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U.S. Department of Energy, Washington, DC

Flood Plain Involvement Notification for Proposed Remedial Action at the Hazelwood Formerly Utilized Site Remedial Action Program (FUSRAP) Site, Hazelwood, Missouri

Federal Register 49(106):22679-22680 (1984, May 31)

The U.S. Department of Energy (DOE) proposes to conduct remedial actions involving removal and control of radioactively contaminated materials in Hazelwood, Missouri, as directed by Congress in the House-Senate Conference report accompanying the Energy and Water Appropriation Act for 1984. Hazelwood lies in the northwestern portion of the St. Louis metropolitan area. Remedial action would involve removal of radioactively contaminated soil and gravel along the shoulders of Latty Avenue. The action is necessary to allow the City of Berkeley (adjacent to Hazelwood) to proceed with plans for storm drain and road improvements. Interim storage of the contaminated material would be on the Hazelwood FUSRAP site located at 9200 Latty Avenue. DOE has determined, based on a review of the National Flood Insurance Program's (Federal Emergency Management Agency) Flood Insurance Maps for the area, that the proposal may involve activities within the floodplain area of Coldwater Creek. (JWF)

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U.S. Department of Energy, Washington, DC

Floodplain Statement of Findings for 1984 Remedial Action To Be Taken at an Athletic Field in Wayne Township, Wayne, NJ

Federal Register 49(205):41270-41273 (1984, October 22)

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

The Formerly Utilized Sites Remedial Action Program (FUSRAP), Department of Energy (DOE), has prepared a floodplain assessment for proposed remedial action in 1984 at an athletic field in Wayne Township, pursuant to 10 CFR 1022.18, Compliance with Floodplain/Wetlands Environmental Review Requirements. The proposed action at the athletic field will take place within the Pompton River 100-year floodplain. Following publication of a notice of floodplain involvement (Federal Register 49:30007, July 25, 1984), DOE prepared a floodplain assessment. No comments were received on the Federal Register notice. Alternatives to the proposed action were identified, environmental impacts evaluated, and mitigating measures identified. Based on the assessment, DOE has determined that there are no practicable alternatives to the proposed action in the floodplain and that it has been designed to minimize potential harm to and within the floodplain. (JWF)

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U.S. Department of Energy, Washington, DC

San Francisco Operations Office - Environment, Safety and Quality Assurance Division - Certification of Radiological Condition of Gilman Hall Site, University of California, Berkeley, CA

Federal Register 50(52):10853-10854 (1985, March 18)

The U.S. Department of Energy (DOE) has completed the radiological surveys and has taken remedial action to decontaminate and shield areas of Gilman Hall that were found to contain low levels of contamination resulting from research conducted in the building in support of the Manhattan Engineer District and Atomic Energy Commission activities. DOE, through the San Francisco Operations Office, has issued the following statement: The DOE Office of Terminal Waste Disposal and Remedial Action and the DOE San Francisco Operations Office have reviewed the final remedial action and radiological survey report of the Gilman Hall Site. Based on this review, the DOE certifies that the condition of the site is radiologically acceptable for restricted use under the controls provided by the University of California's State General License 1333-62 and is therefore removed from the Formerly Utilized Sites Remedial Action Program under the condition that the Campus Office of Environmental Safety and Health continues to survey Gilman Hall and monitor whenever remodeling or renovation takes place. If or when final decontamination of Gilman Hall is required for unrestricted use, it will be accomplished through the normal closeout procedures of Contract DE-AC03-76SF00098. (JWF)

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Walker, E., Bechtel National, Inc., Oak Ridge, TN

A Radiological Records Management System for a DOE Program to Decontaminate Multiple Sites Managed from a Central Office

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 599-601); Transactions of the American Nuclear Society 45:599-601 (1983)

The U.S. Department of Energy has been given the responsibility to decontaminate for unrestricted release a number of sites throughout the United States that were involved in weapons-related research. The majority of the sites are privately owned properties contaminated with low levels of uranium and radium, with Ra-226 being the principal isotope of significance for the radiation protection program. Several of the sites, however, are contaminated with plutonium, strontium, cesium, and tritium. Bechtel has developed a radiation protection program to monitor and control the exposure to radiation and/or radioactive materials for individuals associated with any remedial action site. To maintain control of the required records, a computer data base system has been incorporated into the program to supplement the hard-copy personnel dosimetry records system.

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Wang, J., J. Yang, and P. Merry-Libby, Argonne National Laboratory, Environmental Research Division, Argonne, IL

Radioactive Releases from a Thorium-Contaminated Site in Wayne, New Jersey

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-3, 1985, 592 pp.; (pp. 523-531) (1985)

CHAPTER 3. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

Various residues and wastes from the production of thorium and rare earths from monazite ore are buried on a hillside in Wayne, New Jersey. In addition, contaminated materials (primarily soils) from nearby vicinity properties are being consolidated onto the Wayne site. The U.S. Department of Energy plans to stabilize all the contaminated materials on an interim basis (20 years) until funding is available to remove them to another location. In order to evaluate the effectiveness of interim stabilization measures, preremedial action radioactive releases are compared to estimated releases under a reference stabilization option (one meter of soil cover). Two potential pathways are examined: (1) airborne radioactive gases (thoron and radon) and particulates, and (2) seepage into the near-surface groundwater. The relative reduction of releases into the air and groundwater for the reference stabilization option is analyzed using mathematical models for radioactive gas fluxes and atmospheric dispersion as well as groundwater transport and dispersion. The consequent health implications for nearby individuals and the general population are also estimated. Health effects due to radioactive releases are estimated to be insignificant. (Auth)

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Wynveen, R.A., W.H. Smith, C.M. Sholeen, A.L. Justus, and K.F. Flynn, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL

Formerly Utilized MED/AEC Sites Remedial Action Program: Radiological Survey of the Harshaw Chemical Company, Cleveland, Ohio

DOE/EV-0005/48; ANL-OHS/HP-84-104; 137 pp. (1984, April)

During the MED/AEC era, the Harshaw Chemical Company processed large quantities of normal uranium to produce both oxide and fluoride compounds. Records indicated that the AEC contract was terminated, the facility was decontaminated by Harshaw, and released from AEC control in 1960. However, a search of AEC records indicated that documentation was insufficient to determine whether the decontamination work was adequate by current guidelines. A radiological assessment of the site was initiated in 1976. The entire grounds and all buildings were surveyed using surface survey instruments to detect surface contamination and radiation detectors to determine general radiation levels. Extensive surface contamination was found throughout the site. While the major contamination was found in Plant C, significant levels of contamination also were found in 16 other buildings and at 32 exterior locations. The contaminating materials assessed to be normal uranium exclusively. Air samples were taken at numerous indoor locations throughout the site, but no elevated levels of radon were detected. Several soil samples were taken from around the site. Analyses of these samples indicated extensive soil contamination as well as suspected contamination of the river bed in the vicinity of the plant outfall. Scheduled subsurface investigation of the site, as well as of the river bed and sewer system, have not been conducted. Levels of contamination at this site are significantly above guidelines for release of the site for unrestricted use. (Auth)

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Wynveen, R.A., W.H. Smith, C.M. Sholeen, A.L. Justus, K.F. Flynn, and S.Y. Tsai, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL

Formerly Utilized MED/AEC Sites Remedial Action Program: Geohydrological and Radiological Survey of the Albany Research Center, United States Bureau of Mines, Albany, Oregon

DOE/EV-0005/39 (Suppl. 1); ANL-OHS/HP-84-103; 108 pp. (1983, July)

This report contains survey results describing the geohydrological conditions and supplemental radiological information describing the radiological conditions of two areas located at the United States Bureau of Mines' Albany Research Center in Albany, Oregon. The BioMass Facility was most recently used as a pilot plant for the production of oil from wood waste; at the time of the survey, the facilities were not being routinely used. The Back Forty is a vacant area of about 14 acres south of the BioMass Facility. Both areas were reportedly used in the past as dump sites for the Bureau of Mines operations. The geohydrological assessment included drilling bore holes to assess the hydraulic gradient, the groundwater flow direction, and the extent of subsurface migration of contaminants. The results of this survey are presented. (Auth)(ARE)

Chapter 4

FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

CHAPTER 4. FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

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Abdelrazek, M.M., W.A. Goldsmith, and F.F. Haywood, Oak Ridge National Laboratory, Oak Ridge, TN

Radon-222 and Its Daughters in the Indoor Atmosphere of a Building Contaminated with Uranium Ores

CONF-820335; Applications and Technology of Ionizing Radiations, A.M.A. Al-Soraya (ed.), Proceedings of an International Symposium, Malaz, Riyadh, Saudi Arabia, March 12-17, 1982, Vol. 3; (pp. 1625-1632) (1982)

Concentrations of radon gas (Rn-222) were measured in the indoor atmosphere of a building containing traces of some uranium products using Wrenn chambers. Measured radon gas concentrations at different locations inside the building showed the strong influence of both air exchange process and outdoor radon sources on the removal and accumulation of indoor radon gas. A pronounced increase in indoor concentrations was observed whenever air exchange rate was reduced. Furthermore, quantitative discussions regarding the observed effect of variation in atmospheric pressure on indoor radon concentrations were presented. Concentrations of radon daughters were measured using graph sampling and an alpha spectrometry technique and it was found that they varied over a wide range of values. Data collected on occasions when the indoor atmosphere has the minimum disturbance for several hours were used to evaluate gross removal rates for different radon daughters. Approximate gross removal rates for RaA, RaB and RaC in the ground level of the building were found to be 19, 0.8 and 0.5 (per hour) respectively.

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Aitken, J.H., E.G. Baker, R.M. Chatterjee, R. Kusiak, and J. Tai-Pow

Radon Concentrations in Contaminated and Uncontaminated Premises in Two Ontario Towns

CONF-770231; Radon Workshop, Proceedings of the Third Seminar, New York, NY, February 1977; (pp. 129-131) (1977)

Radon-222 concentrations in air were measured by grab sampling in a large number of private homes and other buildings in the town of Port Hope, Ontario, Canada. These measurements identify places where a health hazard might exist due to improper disposal of radium-contaminated material. Contaminated fill, rubble, lumber, and other building materials have been found in a number of premises in the town. Radon concentrations up to 750 pCi/l have been found in some homes. The thrust of the program is to quickly identify places where interim remedial action such as installation of special ventilation systems is necessary, pending final removal of the contamination. The methods and instrumentation formerly used for radon-in-breath analysis in radium workers are being employed. Grab sampling for radon and gamma surveying in every building in town are combined in a screening program based on experience which has shown that both radon sampling and gamma surveying are required to identify contaminated locations. (JMF)(ARE)

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Atomic Energy Control Board, Ottawa, Ontario, Canada

First Workshop on Radon and Radon Daughters in Urban Communities Associated with Uranium Mining and Processing

AECB-1209; CONF-7803145; Radon and Radon Daughters in Urban Communities Associated with Uranium Mining and Processing, Proceedings of the First Workshop, Elliot Lake, Ontario, Canada, March 7, 1978, 138 pp. (1978)

This meeting of Atomic Energy Control Board staff, representatives of other government departments, and consultants was called to exchange information on steps taken to lower radiation levels in houses in communities such as Elliot Lake, Uranium City, and Port Hope. Discussions covered the sources of radon and radon daughters in these houses, radon measurement techniques, and remedial methods that worked or were not successful.

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Bernhardt, D.E., V.C. Rogers, S.V. Prewett, and L.W. Cole, Rogers and Associates Engineering Corporation, Salt Lake City, UT; Aerojet Heavy Metals Company, Jonesboro, TN

CHAPTER 4. FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

Remedial Action Guides - Depleted Uranium and Thorium in Soil

CONF-850314; Waste Management '85, Proceedings of a Conference, Tucson, AZ, March 24, 1985, Vol. 3; (pp. 129-134) (1985)

Aerojet Heavy Metals Company (AHMC) of Jonesboro, Tennessee, is consolidating soils and sediments contaminated with depleted uranium and Thorium-232 from a storage pile area and from an inactive process waste pond into an on-site disposal area. The disposal area is located adjacent to the developed site, and is contained within a fenced area that is well inside the AHMC property. This paper provides a discussion of the Site and Contaminated Material, Existing Guides and Standards, independent Environmental Pathway Analysis, and guides for the project. These guides are approved by the Tennessee Department of Health and Environment for conducting the remedial action at the AHMC site. The guides are based on present pertinent radiation guidelines and standards of federal and state agencies and on an independent assessment of potential radiation doses. The guides are specifically developed for the AHMC site, and are the basis for the site design and future land use limitations. (Auth)(CAC)

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Case, G., Atomic Energy Control Board, Ottawa, Ontario, Canada

Summary and Historical Review of the Radioactive Cleanup in Port Hope, Ontario

AECB-1164-3; CONF-8003203; Radon and Radon Daughters in Urban Communities Associated with Uranium Mining and Processing, Proceeding of the Third Workshop, Port Hope, Ontario, Canada, March 12, 1980, Part 1, 409 pp.; (pp. 30-36) (1980)

In 1976 several buildings and other areas of the town of Port Hope were found to be contaminated by radium and radon from residues produced by a local uranium refining plant and from materials salvaged from old refinery buildings. In the spring of 1976 the entire town was surveyed and 550 houses were found to have elevated radon gas levels or background radiation levels. Of these, 500 properties were classified as sites requiring remedial work. Large amounts of contaminated soil and fill were removed, as well as other building materials. Demolition was necessary in some cases. For the first three years contaminated materials were stored at the Chalk River Nuclear Laboratories, but finally the waste disposal site there was filled with over 104,000 tons of contaminated soil. By the end of 1979 work had been completed on 441 properties. Work on smaller sites was continuing, but progress on the cleanup of larger areas depended on another disposal area being found.

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Etzweiler, A., T. Lauffenburger, and H. Schaellibaum, Fachverband fuer Strahlenschutz e.V., Karlsruhe, Federal Republic of Germany

Experience Gained in the Decontamination of Rooms Formerly Used for Dial Painting

FS-83-32-T; CONF-8306168; Aspects of Radiation Protection with Regard to Radioactive Contamination, Proceedings of the 17th Annual Meeting of Fachverband fuer Strahlenschutz e.V., Aachen, Federal Republic of Germany, June 8-10, 1983; (pp. 209-218) (1983)

In cases of Ra contamination in rooms formerly used for painting dials, most of the radiation exposure is a result of a concentration of Rn decay products. The decontamination work can be carried out by trained personnel under specialists' instruction and monitoring. To reduce the dose rate and surface contamination, sanitation and waste disposal in accordance with radiation protection requirements is possible, yet costly. Radon sanitation is far less difficult, because radium depositions are usually outside the buildings within the discharge channel system or in former soakage pits. Should the need arise, measures must also be taken for neighboring houses.

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Evans, R.D., J.H. Harley, W. Jacobi, A.S. McLean, W.A. Mills, and C.G. Stewart, Massachusetts Institute of Technology, Cambridge, MA; U.S. Department of Energy, Environmental Measurements Laboratory, New York, NY; Institut fur Strahlenschutz Gesellshaft fur Strahlen und Umwelftorschung mbH, Munich, Federal Republic of Germany; Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada; National Radiological Protection

CHAPTER 4. FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

Board, Harwell, Didcot, Oxfordshire, United Kingdom; U.S. Environmental Protection Agency, Criteria and Standards Division, Washington, DC

Estimate of Risk from Environmental Exposure to Radon-222 and Its Decay Products

Nature 290:98-100 (1981, March 12)

The basis of radiological protection is risk limitation. For example, the dose equivalent limit for workers is set so that the average risk likely to be incurred is comparable with the average prevailing for other workers in industries regarded as having high standards of safety. For members of the public, the level of acceptability of risk is probably an order of magnitude lower. It is important, therefore, to have some information on risk factors for environmental exposure to radon decay products if a system of control is to be considered. Direct risk information does not exist for environmental levels of radon decay products. It is therefore necessary to extrapolate from data for occupational exposure or to infer the risk from the incidence of lung cancer in the wider population. The paper discusses both approaches. (Auth)

385

Jensen, L., G. Regan, S. Goranson, and B. Bolka, U.S. Environmental Protection Agency, Chicago, IL

Ambient Monitoring of Airborne Radioactivity Near a Former Thorium Processing Plant

Health Physics 46(5):1021-1033 (1984, May)

Twenty-four hour sampling for airborne radioactivity near a former thorium and rare-earth extraction facility was conducted for about two months with high-volume and dichotomous air samplers. Thoron (Rn-220) daughters were identified in the air and confirmed to be originating from the waste storage site. High-volume samplers near the facility measured average Pb-212 concentrations of 177, 43, and 237 pCi/cu m. Simultaneous measurements with dichotomous samplers at the same sites measured average Pb-212 concentrations of coarse particulates (2.5-15 micron diameter) of 14, 4 and 10 pCi/cu m and on fine particulates (less than 2.5 micron diameter) of 94, 9 and 214 pCi/cu m, respectively. Uranium, thorium and radium radionuclides were not identified as being present in significant concentrations in the particulate samples.

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NRC, Illinois and Kerr-McGee

Radwaste News 5(13):102 (1984, July 21)

At issue is the cleanup of the West Chicago facility which Kerr-McGee used to process rare earths elements, thorium, and other ores. Tailings containing various radioactive materials, including radium, were left at the site. The U.S. Environmental Protection Agency conducted environmental monitoring around the site and found extensive contamination. The U.S. Nuclear Regulatory Commission (NRC) has signed an agreement with the State of Illinois transferring the inspection responsibility of NRC to the state. Illinois will assure compliance with NRC's regulation on packaging and transportation of low-level waste. The state will also have the responsibility to inspect waste operations of nuclear power reactors. However, the NRC has retained the right for enforcement actions. (Auth)

387

NRC Insists on Cleanup of West Chicago Site

Radwaste News 5(5):34 (1984)

The U.S. Nuclear Regulatory Commission has ordered Kerr-McGee to clean up the West Chicago Site in accordance with the U.S. Environmental Protection Agency's uranium mill tailing standards since radiological surveys have shown levels of thorium at various areas. These standards require no more than 5 pCi radium/g soil over the first 15 cm of soil and no more than 15 pCi/g at soil layers below 15 cm. In addition, the NRC would permit the averaging of contamination over an area of 100 square meters. Kerr-McGee argues that it cannot move the five million cubic feet of contaminated soil and would like to stabilize the tailings on site. (ARE)

388

Taniguchi, H., and P. Vasudev, Department of National Health and Welfare, Radiation Protection Division, Ottawa, Ontario, Canada

Radon and Radon Daughters Due to Natural Uranium Occurrences in a Rural Ontario Community

CHAPTER 4. FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

CONF-780422; Natural Radiation Environment 3, T.F. Gesell and W.M. Lowder, (eds.), Proceedings of the Third International Symposium, Houston, TX, April 23-28, 1978. U.S. Department of Energy, Technical Information Center, Oak Ridge, TN, Vol. 2, 884 pp.; (pp. 1623-1632) (1980)

The results of a survey of Rn-222 and its short-lived radon daughters in 343 homes in the rural community of March Township, near Ottawa, Canada, are reported. Aerial gamma-ray spectrometry carried out over the 90-sq km area showed the presence of up to 5 ppm uranium. The arithmetic average value of the radon daughters in the basement of these homes was 0.014 plus or minus 0.026 WL (working level). Thirteen percent of the homes had radon daughter concentrations exceeding an arbitrary reference value of 0.02 WL and the highest was 0.19 WL. The most frequently observed radon gas values of the homes in this category were in the 5 to 10 pCi/l interval. From these measurements the equilibrium factor between radon and its daughters was shown to be 0.38 plus or minus 0.19. (Auth)

389

Van Dyne, J., and C.B. Daniel, Ohio Materials Company, Findlay, OH

Luminous Processes Company: The Cleanup of a Low-Level Radioactive Waste Site

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 151-153) (1982)

From 1952 to 1978, Luminous Processes Co., Athens, Georgia, used paint containing radium-226 and tritium. The site was left in a contaminated condition after plant closure. Procedures used for decontamination and cleanup are detailed. The project entailed excavation of soil adjacent to the main building, removal of interior walls and fixtures from inside the building, and decontamination of various items on the premises. All cleanup objectives were met and the site was successfully rehabilitated.

390

Wynveen, R.A., W.H. Smith, C.M. Sholeen, and K.F. Flynn, Argonne National Laboratory, Argonne, IL

Radiological Assessment Report for the University of Rochester Annex, Rochester, New York, April-May 1984

ANL-OHS/HP-84-109; 167 pp. (1984)

In light of the results of the comprehensive radiological assessment of the annex and auxiliary facilities, the following conclusions can be made. There is no immediate hazard from the elevated levels of radioactivity detected; however, some of these levels are above criteria. The radon, thoron, actinon, long-lived particulates, and tritium in the air are all below criteria for unrestricted use. Some ductwork has been identified as being contaminated. All ductwork must, therefore, be considered potentially contaminated. Since several floor drains were found to exhibit elevated readings, and the samples had elevated concentrations of radionuclides, it must be concluded that the drain and sewer systems of the annex are contaminated with radioactive material. Because the samples collected from the storm and sewer systems outside the building also had elevated concentrations of radionuclides, these systems are also considered contaminated with radioactive material. The grounds around the annex have exhibited background concentrations of radionuclides. Two rooms, B-330 and B-332, were inaccessible for survey due to the presence of stored furniture and equipment. Therefore, no comment about their radiological status can be made. At the common baseboard for Room C-12 and C-16 and on the floor below the tile in Room C-40, contamination appeared to be masked by construction modifications. Other areas of the annex must also be considered potentially contaminated where modifications may have masked the contamination.

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM DESIGN, PLANNING, AND REGULATIONS

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Proposed Amendment No. 834, by Senator Abdnor to Senate Bill 1207, Authorization of Appropriations for the Nuclear Regulatory Commission

Congressional Record 128(29):S2482-S2483 (1982, March 22)

This amendment directs the U.S. Nuclear Regulatory Commission, in consultation with the EPA, HUD, DOE, TVA, and the State of South Dakota, to establish and coordinate a monitoring, engineering assessment, and remedial action program for the management of byproduct material at offsite locations in the vicinity of the Edgemont, South Dakota, uranium mill site. (JWF)

392

Garvey, R.R., Jr., Advisory Council on Historic Preservation, Golden, CO

Uranium Mill Tailings Remedial Action Program - Memorandum of Agreement

Federal Register 49(204):41079 (1984, October 19)

The Advisory Council on Historic Preservation proposes to execute a Programmatic Memorandum of Agreement (PMOA) pursuant to Section 800.8 of the Council's regulations, "Protection of Historic and Cultural Properties" (36 CFR Part 800), with the U.S. Department of Energy and the Colorado State Historic Preservation Officer. The PMOA provides for the consideration of means to avoid, minimize, or mitigate adverse effects on historic and cultural properties included in or eligible for the National Register of Historic Places in the implementation of the U.S. Department of Energy's Uranium Mill Tailings Remedial Action Program within the State of Colorado. The proposed PMOA will establish procedures by which historic and cultural properties in Colorado will be identified, evaluated, and protected in order to meet the requirements of Section 106 of the National Historic Preservation Act (U.S. Code 16:470f). (JWF)

393

Gillen, D.M., U.S. Nuclear Regulatory Commission, Division of Waste Management, Washington, DC

Geotechnical Engineering Considerations in the NRC's Review of Uranium Mill Tailings Remedial Action Plans

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 13-21) (1985)

To reduce potential health hazards associated with inactive uranium mill tailings sites, the U.S. Department of Energy (DOE) is presently investigating and implementing remedial actions at 24 sites in the Uranium Mill Tailings Remedial Action Program (UMTRAP). All remedial actions must be selected and performed with the concurrence of the U.S. Nuclear Regulatory Commission (NRC). This paper provides a discussion of geotechnical engineering considerations during the NRC's preconcurrence review of proposed remedial action plans. In order for the NRC staff to perform an adequate geotechnical engineering review, DOE documents must contain a presentation of the properties and stability of all in-situ and engineered soil and rock which may affect the ability of the remedial action plans to meet U.S. Environmental Protection Agency standards for long-term stability and control. Site investigations, laboratory testing, and remedial action designs must be adequate in scope and technique to provide sufficient data for NRC staff to independently evaluate static and dynamic stability, settlement, radon attenuation through the soil cover, durability of rock for erosion protection, and other geotechnical engineering factors. (Auth) (DCM)

394

Disposal of Uranium Mill Tailings

Idaho Senate Bill 1276; Idaho Session Laws Chapter 257; 2 pp. (1984)

This act sets forth the guidelines for state participation with the United States in the federal Uranium Mill Tailings Radiation Control Act of 1978. The act authorizes the state radiation control agency to cooperate with the federal government in providing for the stabilization, disposal, and control of uranium mill tailings in a safe and environmentally sound manner. It also defines Idaho's financial participation in the program: 10% of the actual costs of any remedial action and administrative costs and a share of net profits derived from the recovery of minerals. (ARE)

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Meyer, H.R., D.J. Skinner, J.H. Coffman, and W.J. Arthur, Chem-Nuclear Systems, Inc., Columbia, SC; U.S. Department of Energy, Uranium Mill Tailings Remedial Action Program, Canonsburg, PA

Environmental Protection in the UMTRA Project

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 25) (1984, November)

Planning and implementation of a comprehensive environmental protection system within the Uranium Mill Tailings Remedial Action (UMTRA) Project continues to be a complex process. Compliance with a large set of federal, state, and Indian tribal regulations and requirements, and with public requests is necessary. Because the project covers sites in a great variety of climates and terrain, and includes both heavily populated and virtually unpopulated locations, environmental assessment is further complicated. Monitoring of initial remedial action at the Canonsburg, Pennsylvania tailings site indicates that compliance with applicable DOE and NRC regulations and standards for offsite radon and daughters, particulate radionuclides in air, and waterborne radionuclides can be met during cleanup operations. However, as greater quantities of uranium tailings materials are exposed and transported at Canonsburg, a careful link between environmental monitoring and control of releases will be required to ensure compliance. Morrison-Knudsen Corporation, assisted by Chem-Nuclear Systems, Inc., is responsible to the U.S. DOE for performing engineering design, remedial action, and radiological activities at UMTRA sites, and at many UMTRA vicinity properties. This paper focuses on the current implementation of applicable standards and requirements, the procedure and devices currently being employed to operate the environmental monitoring program at UMTRA sites, and summarizes monitoring information acquired recently at the first sites. (Auth) (JWF)

396

Odle, R.C., Jr., U.S. Department of Energy, Washington, DC

Announcement of Extension of Public Comment Period for the Draft Environmental Impact Statement on Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, LaPlata County, CO

Federal Register 50(26):5295 (1985, February 7)

The public comment period on the Draft Environmental Impact Statement (EIS) for the Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, La Plata County, Colorado, is extended through February 25, 1985. This action extends the comment period 45 days from the original closing date of January 11, 1985. (JWF)

397

Uranium Mill Tailings Standards: Continued

Radwaste News 5(11):85 (1984, July 3)

The U.S. Environmental Protection Agency has finished its regulatory process and has promulgated standards for former uranium processing sites and for active uranium ore processing activities. The U.S. Nuclear Regulatory Commission has essentially completed its efforts to implement EPA's standards. The industry and the radiation community continue to be angry, placing the fate of the Resource Conservation and Recovery Act in Congress in doubt. (ARE)

398

DOE Is Implementing Mill Tailings Standards

Radwaste News 5(3):1 (1984, February 23)

The U.S. Department of Energy is launching its remedial action program around uranium processing sites. After the publication of the regulations by the U.S. Environmental Protection Agency, the cleaning up of these sites will be left to DOE. Part of the area around these sites is in private ownership. The article contains a list of affected sites along with the number of private properties around each site. (ARE)

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399
Smith, W.F., U.S. Department of Justice, Washington, DC

Delegating to the Assistant Attorney General for the Land and Natural Resources Division the Duties Imposed Upon the Attorney General by Section 115(b) of the "Uranium Mill Tailings Radiation Control Act of 1978"

Federal Register 50(42):8606-8607 (1985, March 4)

This order delegates to the Assistant Attorney General of the Land and Natural Resources Division the authority provided for in section 115(b) of the Uranium Mill Tailings Radiation Control Act of 1978. The order is to take effect February 15, 1985. (JWF)

400
U.S. Department of Energy, Albuquerque Operations Office, Office of Public Affairs, Albuquerque, NM

Two Public Meetings Scheduled on Lakeview Tailings

DOE News (1984):1 (1984)

Public meetings were held to provide comments and hear about the progress to date for the Lakeview Uranium Mill Tailings Remedial Action site. U.S. Department of Energy, state, and local officials updated area residents on activities at the Lakeview tailings site. Officials also informed the audience about the preparation of the Environmental Assessment of the Lakeview site. (Auth)

401
U.S. Environmental Protection Agency, Washington, DC

Proposed Remedial Action Standards for Inactive Uranium Processing Sites: Extension of Comment Period

Federal Register 46(91):26356 (1981, May 12)

EPA has proposed remedial action standards (40 CFR Part 192) for inactive uranium processing sites (45 FR 27370, April 22, 1980, and 46 FR 2556, January 9, 1981), and announced public hearings on the proposals (46 FR 16278, March 12, 1981). These notices stated that written comments on the proposals should be received by May 11, 1981. This notice extends the comment period to June 15, 1981. (JWF)

402
Vaughan, J.W., Jr., U.S. Department of Energy, Washington, DC

Compliance with the National Environmental Policy Act - Record of Decision for Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, UT

Federal Register 49(201):40436-40439 (1984, October 16)

Pursuant to the Council on Environmental Quality Regulations (40 CFR Part 1505) implementing the procedural provisions of the National Environmental Policy Act (NEPA) and the U.S. Department of Energy's (DOE) guidelines for compliance with NEPA (45 FR 20694, March 28, 1980), the Office of Assistant Secretary for Nuclear Energy of the DOE is issuing a Record of Decision on Remedial Actions at the Former Vitro Chemical Company site (Vitro site), in South Salt Lake, Utah. After consideration of all reasonable project alternatives, the DOE has decided to relocate the residual radioactive materials from the Vitro site to the South Clive site for long-term stabilization and control in compliance with EPA standards. (JWF)

403
Vaughan, W.A., U.S. Department of Energy, Washington, DC

Grand Junction, Colorado - Change in Schedule for Issuing Draft Environmental Impact Statement

Federal Register 49(7):1414-1415 (1984, January 11)

The U.S. Department of Energy (DOE) announces its intent to postpone completion of a Draft EIS regarding selection of an appropriate remedial action to stabilize or control mill tailings derived from the inactive uranium mill near Grand Junction, Colorado. The original schedule for compliance with the National Environmental Policy Act (NEPA) provided for public review of the Draft EIS in late 1983. The new schedule postpones further work on the Draft EIS until January 1985 with public review intended to take place in the Spring of 1985. Remedial action is still scheduled to begin in the Fall of 1986. (JWF)

404

Vaughan, W.A., U.S. Department of Energy, Washington, DC

Rifle, Colorado - Change in Schedule for Issuing Draft Environmental Impact Statement

Federal Register 49(7):1415 (1984, January 11)

The U.S. Department of Energy (DOE) announces its intent to postpone completion of a Draft EIS regarding selection of an appropriate remedial action to stabilize or control mill tailings derived from the inactive uranium mill near Rifle, Colorado. The original schedule for compliance with the National Environmental Policy Act (NEPA) provided for public review of the Draft EIS in late 1983. The new schedule postpones further work on the Draft EIS until January 1985 with public review intended to take place in the Spring of 1985. Remedial action is still scheduled to begin in the Spring of 1987. (JWF)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

405
Allen, J.W., R.A. Showalter, and R.S. Shay, Bendix Field Engineering Corporation, Grand Junction, CO

Radiologic Characterization of Salt Lake City Vitro Site and Contiguous Vicinity Properties Task 1: Radiologic Field Measurements, Appendix B: Field Procedures Manual

GJ-05(83); 65 pp. (1983, April)

Surface and subsurface radiometric measurements were performed and surface and near-surface soil samples were gathered to characterize the radiologic environment at the Salt Lake City, Utah, Vitro (SLC) site and selected contiguous vicinity properties. Descriptions of the field operating procedures used for each type of measurement at the SLC Vitro site and contiguous vicinity properties are contained in this Appendix B, which accompanies the main volume of the Task 1 report. Also included are definitions of the abbreviations and terms used, field safety procedures, qualifications and training of personnel, laboratory procedures, and quality assurance/quality control procedures. In addition, copies of the data collection forms, where appropriate, accompany the specific procedures described in this manual. (Auth)

406
Berven, B.A., and C.A. Little, Oak Ridge National Laboratory, Oak Ridge, TN

Role of the Inclusion Survey Contractor in the Uranium Mill Tailings Remedial Action Program

CONF-850106; Proceedings of the 18th Midyear Topical Health Physics Society Symposium, Colorado Springs, CO, January 6, 1985; (p. 9) (1985)

Twenty-four former uranium mills are involved in the U.S. Department of Energy's Uranium Mill Tailings Remedial Action Program (UMTRAP). The Radiological Survey Activities project at Oak Ridge National Laboratory serves as the Inclusion Survey Contractor (ISC) in the UMTRA program. Responsibilities of the ISC are: (1) to identify potentially contaminated sites in the vicinity of these former uranium mills; (2) conduct radiological surveys to assess whether the property is contaminated with material originating from the mill in excess of U.S. Environmental Protection Agency criteria formulated specifically for the UMTRA program (40 CFR 192); and (3) provide recommendations to DOE regarding remedial action. Properties are identified by the ISC using historical information, aerial and ground-level gamma scanning, and surveying erosional pathways (wind and water movement of contamination from primary sources). Currently, over 8000 vicinity properties have been identified that warrant further investigation. Once identified, an inclusion survey is conducted to assess whether a property is sufficiently contaminated to warrant inclusion into the UMTRA program. The inclusion survey includes a complete gamma scan of the surfaces of the property outdoors and the lowest habitable level indoors, collection of soil samples outdoors, and radon daughter samples indoors if required. Survey methods are described.

407
Bone, M., T. Schruben, and R. Portillo, Jacobs Engineering Group, Inc., Albuquerque, NM

Modeling Flood Events for Long-Term Stability

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 153-162) (1985)

The primary objective for the disposal of uranium mill tailings in the Uranium Mill Tailings Remedial Action (UMTRA) Project is isolation and stabilization to prevent their misuse by man and dispersal by natural forces such as wind, rain, and flood waters (40 CFR Part 192). Stabilization of sites that are located in or near flood plains presents unique problems in design for long-term performance. The process involved with the selection and hydrologic modeling of the design flood event and the hydraulic modeling with geomorphic considerations of the design flood event are discussed. The Gunnison, Colorado and Riverton, Wyoming sites are used as examples in describing the process. (Auth)(DCM)

408
Brinkman, J.E., J.R. Hoopes, and P.W. Zelle, Ser-

gent, Hauskins and Beckwith Geotechnical Engineers, Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM; Weston (Roy F.), Inc., Albuquerque, NM

Hydrologic Site Characterization - The UMTRA Project Approach

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 131-136) (1985)

The U.S. Environmental Protection Agency (EPA) Standards (40 CFR 192) require site characterization of the hydrogeologic regime at and around each Uranium Mill Tailings Remedial Action (UMTRA) Project site. Also, "judgements on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 CFR 32274)." To address those two sets of rules and regulations, a generic approach is being developed. Fourteen primary issues were determined. These issues can be grouped into those that can be determined by documentation of available information and present conditions, those that require extensive field investigations and those that require some form of predictive modeling. To address the various issues requires an integrated effort of hydrogeologists, environmental engineers or scientists and health physicists. In this paper, the approach to the resolution of these fourteen issues is described briefly. (Auth)

409

Brinkman, J.E., R. Rager, and K. Ries, Sergent, Hauskins and Beckwith Geotechnical Engineers, Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM

Evaluation of Geotechnical and Geohydrologic Criteria for Potential Disposal Areas

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 199-207) (1985)

Long-term stabilization of uranium mill tailings presents unique problems for geotechnical and geohydrologic siting considerations at proposed disposal sites. These include geomorphic conditions of proposed disposal sites such as erosion, river meander, and slope stability; and groundwater considerations of depth to groundwater, aquifer recharge, flow, definition of background quality and other aquifer characteristics. Numerous site selection criteria are considered that are different than those used in siting industrial facilities. A formal site selection process has been developed in order to determine suitable sites for long-term stabilization of uranium mill tailings for the DOE-sponsored UMTRA program. Key factors in this process are regional and site specific geotechnical and geohydrologic considerations. A multiphase approach, discussed in another paper, was designed to rank selected sites according to geotechnical/geohydrologic, engineering, and environmental considerations. This paper concentrates on the detailed field investigations used to finalize the geotechnical and geohydrologic characterization of the two highest ranked sites. (Auth)(DCM)

410

Coffman, J.H., H.R. Meyer, and D.J. Skinner, Chem-Nuclear Systems, Inc., Albuquerque, NM

Radiological Measurements To Support Remedial Action on Uranium Mill Tailings

CONF-841105; Nuclear Power - A Global Reality, Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (pp. 53-54); Transactions of the American Nuclear Society 47:53-54 (1984)

The purpose of this paper is to familiarize the reader with the Uranium Mill Tailings Remedial Action Program and the radiological measurements being utilized to demonstrate compliance to the remedial action standards. On November 8, 1978, Public Law 95-604 was enacted to address potential public health hazards associated with several abandoned uranium mill tailings sites. The U.S. Department of Energy (DOE) was tasked with coordinating the remedial action efforts and the U.S. Environmental Protection Agency (EPA) was tasked with promulgating standards for the effort. The EPA standards for remedial actions at inactive uranium sites

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were made effective as of March 7, 1983. The law provides DOE with a seven-year time limit to accomplish remedial action from the effective date of the standards. There are 24 sites designated for remedial action and approximately 6000 vicinity properties that will require some remedial action. The EPA established two categories of standards. The first is a design standard for the control of the residual material. The second category is for the cleanup of land and buildings. Two radiological measurement systems are being used to demonstrate compliance with remedial action standards at abandoned uranium mill sites. A soil analysis system that utilizes a large sample and relatively simple equipment is described. An integrated radon gas measurement is being proposed to determine annual average working levels. (Auth)(CAC)

411

Darr, P., J.E. Brinkman, and L. Stepp, Sergent, Hauskins and Beckwith Geotechnical Engineers, Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM

Surface Geophysics at the UMTRA Project Site in Lakeview, Oregon

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 137-142) (1985)

Prior to initiating an expensive drilling and testing program to determine the hydrogeologic features underlying an abandoned uranium mill tailings pile and raffinate ponds, reconnaissance level electromagnetic induction and surface electrical resistivity profiling were conducted to map apparent ground conductivity at and around the Lakeview site. Three hundred sixteen electromagnetic induction measurements and 28 electrical resistivity measurements were obtained to prepare a conductivity map for an area of approximately 500 acres. Contouring of these geophysical measurements indicated the intensity and extent of contaminant plumes. The plume characteristics were subsequently confirmed by measurements of total dissolved solids from groundwater samples. The design of the groundwater monitoring and hydrogeologic testing programs were based upon the results of the geophysical surveys. (Auth)

412

Deb, A., S. Colarullo, and J. Snyder, Weston (Roy F.), Inc., West Chester, PA; Sergent, Hauskins and Beckwith Geotechnical Engineers, Inc., Albuquerque, NM

Groundwater Modeling for Uranium Mill Tailings Sites

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 391-399) (1985)

There are 25 designated inactive uranium mill tailing sites in the nation. The U.S. Department of Energy has been authorized to administer the Uranium Mill Tailings Remedial Action Program (UMTRAP) which addresses the problem of uranium mill tailings disposal sites. These sites have several significant environmental impacts which include surface emission of gamma radiation and radon gas, and potential contamination of ground water by radionuclides leached from the tailings. Engineering solutions to mitigate these impacts involve encapsulating and/or covering the tailings pile. The cover is designed to act as a barrier to moisture penetration and to reduce surface emissions of gamma radiation and radon gas. For further protection a liner can be included to intercept any leachate that may have formed. This paper describes a methodology involving a series of models which will be applied as a system to uranium mill tailings sites for evaluation of various remedial measure alternatives. The modeling package developed to predict groundwater quality consists of a flow model, a transport model, and a chemical mixing model. This modeling system has been used in history matching and predicting groundwater quality under a long-term period for the Riverton site. The flow model was able to predict changes in the moisture profile in the unsaturated tailings pile in response to variable precipitation and evapotranspiration conditions. The model indicated that seasonal variations in the moisture profile in the unsaturated zone would occur. Most infiltration will occur during the cooler months when most of the precipitation occurs. During the warmer months, high potential evapotranspiration provides an effective barrier to infiltration. (DCM)

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Dodson, M.E., G.W. Gee, and R.J. Serne, Pacific Northwest Laboratory, Richland, WA

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Interactions of Tailings Leachate with Local Liner Materials Found at Canonsburg, Pennsylvania

DOE/UMT-0219; PNL-5046; 54 pp. (1984, April)

Column studies of tailings leached with deionized water indicated that the Canonsburg tailings could represent a source of soluble radium-226 and uranium-238, several trace metals, cations, and the anions SO4, NO3, and Cl. Of these soluble contaminants, uranium-238, radium-226, the trace metals As and Mo, and the anions F and SO4 were present at levels exceeding maximum concentration levels in the tailings leaching column effluents. Local clays, both in amended and unamended form, were effective in attenuating contaminant migration. Both types of clay removed high levels of trace metals and uranium-238 but were ineffective in removing the anions SO4, NO3, and Cl from the waste stream. Radium-226 was attenuated by the proposed clay liner materials, but the results suggest further studies of the movement of radium through these local clays. The soil amendments tested failed to increase radium attenuation. The tailings leaching studies indicated that the tailings will produce leachates of neutral pH and relatively low contaminant levels for at least 200 years. Compacting the tailings within the encapsulation cell will help to reduce leaching of contaminants from the liner system, since very low permeabilities were observed for even slightly compacted tailings materials.

414

Donovan, T.K., and C.H. Langdon, Tennessee Valley Authority, Knoxville, TN

Site Cleanup Lessons Learned: Case Studies - Edgemont Site

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

This paper is divided into 3 parts: (1) a description of the U.S. Nuclear Regulatory Commission Final Environmental Statement Related to the Decommissioning of the Edgemont Uranium Mill (NUREG-0846); (2) information about nonsignificant differences to the NRC's final environmental statement; and (3) Notice of adoption of Final Environmental (Impact) Statement. TVA has determined that the environmental statement adequately assesses the decommissioning of the Edgement mill and as a consequence has adopted the statement as TVA's final environmental impact statement. While TVA agrees with the key conclusions and believes that the proposed action can be undertaken consistent with applicable health, safety, and environmental requirements, in adopting the statement TVA does not necessarily subscribe to every judgement, rationale, or methodology used by the NRC. (ARE)

415

Ecker, R.M., Pacific Northwest Laboratory, Richland, WA

Effects of Rock Riprap Design Parameters on Flood Protection Costs for Uranium Tailings Impoundments

NUREG/CR-3751; PNL-5068; 89 pp. (1984, July)

The Pacific Northwest Laboratory (PNL) is studying the problem of long-term protection of earthen covers on decommissioned uranium tailings impoundments. The major erosive forces acting on these covers will be river flooding and overland flow from rainfall-runoff. For impoundments adjacent to rivers, overbank flooding presents the greater potential for significant erosion. To protect the earthen covers against flood erosion, rock riprap armoring will be placed over the cover surface. Because of the large size rock usually required for riprap, the quarrying, transport, and placement of the rock could be a significant part of the decommissioning cost. This report examines the sensitivity of riprap protection costs to certain design parameters at tailings impoundments. The parameters include flood discharge, riprap materials, impoundment side slopes, and an added safety factor. Two decommissioned tailings impoundments are used as case studies for the evaluation. These are the Grand Junction, Colorado impoundment located adjacent to the Colorado River and the Slickrock, Colorado impoundment located adjacent to the Dolores River. The evaluation considers only the cost of riprap protection against flood erosion. The study results show that embankment side slope and rock specific gravity can have optimum values or ranges at a specific site. For both case study sites the optimum side slope is about 5H:1V. Of the rock sources considered at Grand Junction, the optimum specific gravity would be about 2.50; however, an optimum rock specific gravity for the Slickrock site could not be determined. Other results indicate that the arbitrary safety factor usually added in riprap design can lead to large increases in protection costs.

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Measurements of Uranium Mill Tailings Consolidation Characteristics

NUREG/CR-4087; 40 pp. (1985, February)

A series of experiments were conducted on uranium mill tailings from the tailings pile in Grand Junction, Colorado to determine their consolidation characteristics. Three materials (sand, sand/slimes mix, slimes) were loaded under saturated conditions to determine their saturated consolidated behavior. During a separate experiment, samples of the slimes material were kept under a constant load while the pore pressure was increased to determine the partially saturated consolidation behav Results of the saturated tests compared well with lished data. Sand consolidated the least, while slimes consolidated the most. As each material consolidated, the measured hydraulic conductivity decreased in a linear fashion with respect to the void ratio. Partially saturated experiments with the slimes indicated that there was little consolidation as the pore pressure was increased progressively above 7 kPa. The small amount of consolidation that did occur was only a fraction of the amount of saturated consolidation. Preliminary measurements between pore pressures of 0 and 7 kPa indicated that measurable consolidation could occur in this range of pore pressure, but only if there was no load.

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Flynn, K.F., A.L. Justus, C.M. Sholeen, W.H. Smith, and R.A. Wynveen, Argonne National Laboratory, Occupational Health and Safety Division, Argonne, IL

Radiological Survey of Shiprock Vicinity Property SH02, Shiprock, New Mexico, August-November 1982

DOE/NE-SH02; ANL-OHS/HP-84-SH02; 67 pp. (1984, May)

At the request of the U.S. Department of Energy, a detailed radiological assessment of the vicinity properties at Shiprock, New Mexico, was conducted. As part of that assessment, a comprehensive survey of the vicinity property designated "SH02" was conducted on an intermittent basis from August 27 to November 11, 1982. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analysis of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates and short-term radon daughter measurements within the residence did not exceed U.S. Environmental Protection Agency (EPA) standards. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Since the surface soil contamination levels exceeded the limits specified in the EPA standard, remedial action for this vicinity site should be considered. (Auth)(ARE)

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Radiological Survey of Shiprock Vicinity Property SH04, Shiprock, New Mexico, September-November 1982

DOE/NE-SH04; ANL-OHS/HP-84-SH04; 68 pp. (1984, May)

At the request of the U.S. Department of Energy, a detailed radiological assessment of the vicinity properties at Shiprock, New Mexico, was conducted. As part of that assessment, a comprehensive survey of the vicinity property designated "SH04" was conducted on an intermittent basis from September 1 to November 11, 1982. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at

1-meter heights; and analysis of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates and short-term radon daughter measurements within the residence did not exceed U.S. Environmental Protection Agency (EPA) standards. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Since the surface soil contamination levels exceeded the limits specified in the EPA standard, remedial action for this vicinity site should be considered. (Auth)(ARE)

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Radiological Survey of Shiprock Vicinity Property SH05, Shiprock, New Mexico, August-November 1982

DOE/NE-SH05; ANL-OHS/HP-84-SH05; 67 pp. (1984, May)

At the request of the U.S. Department of Energy, a detailed radiological assessment of the vicinity properties at Shiprock, New Mexico, was conducted. As part of that assessment, a comprehensive survey of the vicinity property designated "SH05" was conducted on an intermittent basis from August 27 to November 11, 1982. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analysis of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates and short-term radon daughter measurements within the residence did not exceed U.S. Environmental Protection Agency (EPA) standards. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Since the surface soil contamination levels exceeded the limits specified in the EPA standard, remedial action for this vicinity site should be considered. (Auth)(ARE)

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Radiological Survey of Shiprock Vicinity Property SH06, Shiprock, New Mexico, August-November 1982

DOE/NE-SH06; ANL-OHS/HP-84-SH06; 67 pp. (1984, May)

At the request of the U.S. Department of Energy, a detailed radiological assessment of the vicinity properties at Shiprock, New Mexico, was conducted. As part of that assessment, a comprehensive survey of the vicinity property designated "SH06" was conducted on an intermittent basis from August 27 to November 11, 1982. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analysis of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates and short-term radon daughter measurements within the residence did not exceed U.S. Environmental Protection Agency (EPA) standards. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Since the surface soil contamination levels exceeded the limits specified in the EPA standard, remedial action for this vicinity site should be considered. (Auth)(ARE)

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CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

Radiological Survey of Shiprock Vicinity Property SH07, Shiprock, New Mexico, September-November 1982

DOE/NE-SH07; ANL-OHS/HP-84-SH07; 75 pp. (1984, May)

At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were, for the most part, landscaped with lawn cover and other vegetation. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. A general area of elevated radioactivity was found in the front yard and alley, encompassing about 2300 sq ft. Elevated levels were also found in the northwest corner of the property, encompassing about 320 sq ft, and in the southeast corner, encompassing about 39 sq ft. An area of elevated radioactivity was found at a backyard slab, constructed of decorative flagstone and encompassing about 160 sq ft. Radiochemical analyses of the soil sample collected from the southeast corner indicated a radium concentration of 41 plus or minus 5 pCi/g, which is in excess of the limit of 5 pCi/g above background. Analyses of a surface soil sample collected in the alley from an adjacent vicinity property site also indicated a radium concentration in excess of those limits. Subsurface soil sampling was not conducted. Remedial action for this vicinity site should be considered.

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Radiological Survey of Shiprock Vicinity Property SH08, Shiprock, New Mexico, October-November 1982

DOE/NE-SH08; ANL-OHS/HP-84-SH08; 73 pp. (1984, May)

At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were, for the most part, landscaped with lawn cover and other vegetation. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background. The assessment did indicate elevated levels of radioactivity at a few areas in the outside environs. A general area of elevated radioactivity was found at the west edge of the property, paralleling the roadway and encompassing an area of about 70 sq ft, and another general area of contamination was found in the backyard, encompassing about 960 sq ft, and extending into the alley, encompassing a general area of about 1100 sq ft there. Radiochemical analyses of the soil sample collected from the general area in the backyard indicated a radium concentration of 6.7 plus or minus 0.7 pCi/g, which cannot be confidently interpreted to be below the limit of 5 pCi/g above background, averaged over the first 15 cm of soil below the surface. However, analyses of surface soil samples collected at the alleyway from nearby vicinity property sites indicated radium concentrations in excess of those limits. Subsurface soil sampling was not conducted, and thus the vertical extent of the radiological contamination is not known. Remedial action for this vicinity site should be considered.

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Radiological Survey of Shiprock Vicinity Property SH09, Shiprock, New Mexico, October-November 1982

DOE/NE-SH09; ANL-OHS/HP-84-SH09; 75 pp. (1984, May)

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At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were landscaped with lawn cover and trees. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background as specified in the EPA Standard. The assessment indicated elevated levels of radioactivity at several areas in the outside environs. A general area was found along the west side of the residence, encompassing about 160 sq ft, and a discrete hot spot of localized area was found near the back porch of the residence. General areas of elevated radioactivity also were found at the west edge of the property, paralleling the roadway and encompassing about 120 sq ft, and at the alley, encompassing about 1300 sq ft. Radiochemical analyses of the soil sample collected from the west edge of the property indicated a radium concentration of 24 plus or minus 2 pCi/g, which is in excess of the limit of 5 pCi/g above background. Analyses of surface soil samples collected at the alleyway from nearby vicinity property sites also indicated radium concentrations in excess of the limits. Subsurface soil sampling was not conducted. Remedial action for this vicinity site should be considered.

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Radiological Survey of Shiprock Vic. Property SH10, Shiprock, New Me. October-November 1982

DOE/NE-SH10; ANL-OHS/HP-84-SH10; 75 pp. (1984, May)

At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were, for the most part, landscaped with lawn cover and other vegetation. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background. The assessment did indicate elevated levels of radioactivity at several areas in the outside environs. A general area was found along the east edge of the property, paralleling the roadway and encompassing about 24 sq ft, and two discrete hot spots or localized areas were detected in the southeast corner of the property. Additionally, general areas were found near the southwest corner of the structure, encompassing about 6.8 sq ft; to the west of the structure, encompassing about 60 sq ft; and at the west edge of the property and alley, encompassing about 1400 sq ft. Radiochemical analyses of the soil sample collected from this area indicated a radium concentration of 19 plus or minus 2 pCi/g, which is in excess of the limit of 5 pCi/g above background. Subsurface soil sampling was not conducted. Remedial action for this vicinity site should be considered.

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Radiological Survey of Shiprock Vicinity Property SH11, Shiprock, New Mexico, October-November 1982

DOE/NE-SH11; ANL-OHS/HP-84-SH11; 73 pp. (1984, May)

the time of the survey, one residential structure used s a business office was located on the property. The lands surrounding the structure were, for the most part, landscaped with lawn cover and other vegetation. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background. The assessment did indicate elevated levels of radioactivity at a few areas in the outside environs. Two discrete hot spots or localized areas were found in the front yard. A general area of elevated radioactivity was found at the back alley encompassing about 1100 sq ft. Radiochemical analyses of the sample collected from one of the localized areas indicated the presence of natural uranium ore and a radium concentration of 165 plus or minus 17 pCi/g, which is in excess of the limit of 5 pCi/g above background. Analyses of surface soil samples collected at the alleyway from nearby vicinity property sites also indicated radium concentrations in excess of the limits. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Remedial action for this vicinity site should be considered.

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Flynn, K.F., A.L. Justus, C.M. Sholeen, W.H. Smith, and R.A. Wynveen, Argonne National Laboratory, Argonne, IL

Partial Radiological Survey of Shiprock Vicinity Property SH13, Shiprock, New Mexico, November 1982

DOE/NE-SH13; ANL OHS/HP-84-SH13; 62 pp.()

As part of a detailed radiological assessment of the vicinity properties at Shiprock, a comprehensive survey of the vicinity property designated as SH13 was initiated on November 19, 1982. At that time, a single residential structure existed in the northwest corner of the property. The lands surrounding the structure were extensively cluttered with junk. The initial assessment activities were limited to measurements within the residential structure of the ambient external penetrating radiation level at a 1-meter height and analyses of indoor air samples for airborne radioactivity. The external penetrating radiation exposure rate (12.3 uR/hr) was less than the 20 uR/hr above background limit specified in the EPA Standard (40 CFR 192.12[b][2]). As determined by the air samples, the short-term radon daughter concentration within the structure (0.36 mWL) did not exceed the 0.02 WL (or 20 mWL) limit for average annual concentration including background as specified in the EPA Standard. Further measurements required to completely determine the radiological status of this vicinity property, such as measurements of surface radiation both indoors and outdoors and collection and analyses of soil samples, were planned for the final phase of this assessment. However, that phase of the program was terminated before these measurements were accomplished. Thus, the extent of outdoor radiological contamination is presently unknown, and the evaluation of indoor contamination (if any) is incomplete.

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Partial Radiological Survey of Shiprock Vicinity Property SH14, Shiprock, New Mexico, October-November 1982

DOE/NE-SH14; ANL-OHS/HP-84-SH14; 67 pp. (1984, May)

As part of a detailed radiological assessment of the vicinity properties at Shiprock, a comprehensive survey of the vicinity property designated as SH14 was initiated during October and November 1982. At the time of the survey, vicinity property SH14 consisted of about 20 acres of open lands to the northeast of, and directly across the San Juan River from, the upper tailings pile at Shiprock. The lands consisted of a sandy soil, sparsely covered with trees and other vegetation. The partial assessment activities included determination of surface radiation levels on about a 2-meter grid spacing through direct instrument surveys and analysis of a soil sample collected from the area. The partial radiological assessment indicated elevated levels of radioactivity at several general areas within the open lands. Radiochemical analyses of the soil sample collected from one of these areas indicated a radium concentration of 18 plus or minus 2 pCi/g, which is in excess of the limit of 5 pCi/g above background, averaged over the first 15 cm of soil below the surface, as specified in the EPA Standard (40 CFR 192). Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Further measurements required to completely determine and accurately report the radiological status of this vicinity property, including additional

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

direct instrument surveys, collection and analyses of soil samples, and the establishment of a 200-ft grid system, were planned for the final phase of this assessment. However, that phase of the program was cancelled before these measurements were accomplished. The total extent of the radiological contamination of vicinity property SH14 is presently unknown. Nonetheless, since the surface soil contamination levels exceeded the limits specified in the EPA Standard, remedial action for this vicinity site should be considered.

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Flynn, K.F., A.L. Justus, C.M. Sholeen, W.H. Smith, and R.A. Wynveen, Argonne National Laboratory, Argonne, IL

Radiological Survey of Shiprock Vicinity Property SH15, Shiprock, New Mexico, October-November 1982

DOE/NE-SH15; ANL-OHS/HP-84-SH15; 74 pp. (1984, May)

At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were landscaped with lawn cover and other vegetation. The lands in the unlandscaped east section contained a large garden plot and a dirt driveway leading to the back easement. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit specified in the EPA Standard. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background as specified in the EPA Standard. The assessment indicated elevated levels of radioactivity in the outside environs. General areas of contamination were found in the backyard, along the back easement and encompassing about 1200 sq ft of land area there, and extending into the unlandscaped east section, encompassing about 2400 sq ft there. Several discrete hot spots or localized areas were found within these general areas. Radiochemical analysis of the soil samples collected from the areas indicated radium concentrations of 64 plus or minus 6 and 82 plus or minus 8 pCi/g, which are in excess of the limit of 5 pCi/g above background. Subsurface soil sampling was not conducted; thus the vertical extent of the radiological contamination is not known. Remedial action for this vicinity site should be considered.

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Flynn, K.F., A.L. Justus, C.M. Sholeen, W.H. Smith, and R.A. Wynveen, Argonne National Laboratory, Argonne, IL

Radiological Survey of Shiprock Vicinity Property SH16, Shiprock, New Mexico, October-November 1982

DOE/NE-SH16; ANL-OHS/HP-84-SH16; 73 pp. (1984, May)

At the time of the survey, one residential structure was located on the property. The lands surrounding the structure were landscaped with lawn cover and other vegetation. The assessment activities included determination of indoor and outdoor surface radiation levels, for both fixed and removable contamination, through direct instrument and smear (indoor only) surveys; measurement of ambient external penetrating radiation levels at 1-meter heights; and analyses of air and soil samples. No evidence of radioactive contamination was found in the residential structure; background levels of radioactivity were indicated throughout. Radiation exposure rates were less than the 20 uR/hr above background limit. Short-term radon daughter measurements did not exceed the 0.02 WL limit for average annual concentration including background. The assessment indicated elevated levels of radioactivity at several areas in the outside environs. Three localized areas, or discrete hot spots, were found within the backyard. A general area of elevated radioactivity was found at the back alley, encompassing about 1200 sq ft. Radiochemical analyses of the soil sample collected from the backyard indicated a radium concentration of 14 plus or minus 1 pCi/g, which is in excess of the limit of 5 pCi/g above background. Analyses of surface soil samples collected at the alleyway from nearby vicinity property sites also indicated radium concentrations in excess of the limit. Subsurface soil sampling was not conducted, and thus the vertical extent of the radiological contamination is not known. Remedial action for this vicinity site should be considered.

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Flynn, K.F., A.L. Justus, C.M. Sholeen, W.H. Smith, and R.A. Wynveen, Argonne National Laboratory, Argonne, IL

Radiological Survey of Shiprock Vicinity Property SH17, Shiprock, New Mexico, August-November 1982

DOE/NE-SH17; ANL-OHS/HP-84-SH17; 65 pp. (1984, May)

The assessment activities included determination of indoor surface radiation levels in two buildings through direct instrument surveys, measurement of ambient external penetrating radiation levels at 1-meter heights, and analysis of air samples. No evidence of radioactive contamination was found inside either building; the assessment indicated no elevated levels of radioactivity that could not be attributed to the structural materials used in the construction of the buildings. The levels of radiation that were detected from these sources were considered normal for the glazed-tile and cement-block materials encountered. Radiation exposure rates were less than the 20 uR/hr above background limit specified in the EPA Standard. Short-term radon daughter measurements within the buildings did not exceed the 0.02 WL limit for average annual concentrations including background as specified in the EPA Standard. The assessment did not indicate the presence of residual radioactive material under the provisions of the Uranium Mill Tailings Radiation Control Act of 1978. Remedial action for this vicinity site should not be considered.

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Evaluating Geomorphic Hazards from River Behavior - Durango, Riverton, and Gunnison UMTRA Project Sites

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 143-152) (1985)

The geomorphic settings of three UMTRA project sites and methods used to evaluate associated fluvial hazards are reviewed. The results of these studies, and a comparison with separate analyses of the probable maximum flood (PMF) at each site, yield the following conclusions: (1) a reconnaissance is the preferred method for defining the needed scope and emphasis of geomorphic hazard evaluations; (2) the reliability of an evaluation is grossly affected by the geologic record preserved in each study area; (3) in many cases, the probability of a hazard from slow erosional processes may be higher than the probability of catastrophic flooding; and (4) the Holocene geologic record may not contain evidence of floods similar to the calculated PMF. (Auth)

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Goodknight, C.G., and B.W. Walker, Bendix Field Engineering Corporation, Grand Junction, CO

Radiologic Characterization of the Tuba City, Arizona, Uranium Mill Tailings Remedial Action Site

GJ-23; 92 pp. (1984, September)

The objective of the radiologic characterization of the inactive uranium millsite at Tuba City, Arizona, was to determine the horizontal and vertical extent of radioactive contamination that exceeds Environmental Protection Agency standards. The data presented in this report are required for characterization of the tailings pile and for identification and design of cleanup activities. Some sampling was done on the tailings piles to aid in the design of the radon barrier cover. (Auth)

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Radon Flux Monitoring of Covered Uranium Mill Tailings at Grand Junction, Colorado

Transactions of the American Nuclear Society 41:70-71 (1982)

Cover technology for inactive uranium mill tailings sites, including asphalt emulsions seals and multilayer and single-layer earthen cover systems that act as a diffusion barrier to radon, are being developed. A radon flux measurement system that (1) samples a significant area, (2) is unaffected by barometric pressure and temperature changes, and (3) is able to measure a wide range of radon fluxes was designed. The system has been used to monitor the effectiveness of radon barriers at Grand Junction, Colorado for two years, showing that radon fluxes can be significantly reduced using asphalt emulsion, multi-, and single-layer earthen cover systems. (ARE)

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Edgemont Uranium Mill Decommissioning, Fall River County, South Dakota (Adoption as a Final Environmental Impact Statement (EIS) of the Nuclear Regulatory Commission's Final EIS of September 1982): Final Environmental Impact Statement

Information Resources Press, Arlington, VA; 286 pp. (1983)

Decommissioning of the existing uranium milling facilities at Edgemont, South Dakota is proposed. In this adoption by the Tennessee Valley Authority of the U.S. Nuclear Regulatory Commission's final environmental impact statement on the decommissioning, no significant deviations from the NRC statement are presented. The project would prevent human exposure to radioactive material emitted by the defunct mill and its ancillary facilities. Reclamation of mill and waste impoundment sites would ensure their future usefulness for wildlife habitat and other purposes. Grading operations could result in occasional particulate levels that exceed federal air quality standards. Disturbance of soils at the sites would degrade the quality of these soils. Approximately 501 acres of land, including 30 acres of land to be used as haul roads, would be denuded; 86 acres of farmland within the disposal site would be lost. As much as 105 acre-feet of water could be removed from the Pahasapa Aquifer. All aquatic communities in Cottonwood Creek would be destroyed during cleanup operations, although the creek would be repopulated. Windblown tailings would increase downwind radiation levels during decommissioning activities.

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Radiological Assessment of the Town of Edgemont

NUREG/CR-4057; PNL-5320; 189 pp. (1985, January)

Congress, in 1980, gave the U.S. Nuclear Regulatory Commission (NRC) the responsibility to coordinate and conduct a monitoring, engineering assessment, and remedial cleanup program in Edgemont, South Dakota. The intent was to locate public properties in Edgemont that had been contaminated by radioactive materials from a local uranium mill, and to clean up those properties. NRC, through Pacific Northwest Laboratory (PNL), conducted a radiological survey of 96% of the total 976 properties in Edgemont and vicinity during the period September, 1980, through April, 1984. The strategy of the survey was to screen properties for the possible presence of contamination by using short- and long-term radon progeny measurements, indoor and outdoor gamma exposure rate measurements, and soil radium-226 measurements. Properties that failed the screening surveys were measured more extensively to determine whether the elevated readings were due to residual radioactive materials from the uranium mill. This report contains the historical perspective of the Edgemont survey, explains the development and modifications of survey protocols, examines the problems encountered during the survey, and summarizes the results. Conclusions about the effectiveness of the survey techniques and about the rationale of a comprehensive survey of a whole community are also given. Survey protocols are described, a list of all the properties showing survey results for each is presented, and special studies conducted during the survey are described. The special studies contain many insights that may prove beneficial to future radiological assessment surveys. (Auth)(DCM)

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Johnson, K., GECR, Inc., Rapid City, SD

Evaluation of Aquifer Reclamation by Geochemical Modeling and Solid Analysis Example from Gunnison Tailings

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 421-430) (1985)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

Geochemical modeling of the interaction of the groundwater with seepage from a waste source and analysis of the solid phases provide the data required to evaluate options for reclamation of contaminated aquifers associated with waste sites. Methods used to produce and interpret data to characterize the potential for long-term aquifer contamination are demonstrated by the investigations of the Gunnison inactive uranium mill tailings. In the permeable alluvium below the Gunnison tailings, significant quantities of seepage occurred. Analysis of groundwater from the upper part of the shallow aquifer shows above-background levels of uranium; whereas, the lower part of the aquifer does not contain elevated uranium concentrations. The entire aquifer contains above-background concentrations of sulfate controlled by equilibrium with gypsum. Geochemical analysis of the groundwater indicates that the decrease in uranium is due to a decrease in the redox potential (Eh) of the groundwater, which causes the uranium to precipitate as uraninite. Optical analysis of the soils indicates the presence of pyrite, which buffers the groundwaters at a low Eh. Remobilization of the uraninite is likely upon the introduction of oxidizing water during pumping for aquifer restoration. Prediction of the potential for the mobilization of the uraninite requires an understanding of the redox buffering capacity of the soils and the rates of the redox reactions relative to flow rates. (Auth) (DCM)

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MacDonald, R.R., Weston (Roy F.), Inc., Albuquerque, NM

Influence of Sampling Patterns of the Statistical Decision Procedures for a Uranium Mill Tailing Site

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 63-64); Transactions of the American Nuclear Society 45:63-64 (1983)

The effect of different sampling methods on the statistical uncertainties of radiological measurements at Uranium Mill Tailing Remedial Action Program (UMTRAP) sites are examined. The effects of several different sampling patterns and sampling sizes for radiological data at UMTRAP sites are examined by statistical procedures to test for estimates of the true population values and to measure the statistical uncertainties.

438

Mares, J.W., U.S. Department of Energy, Washington, DC

Floodplain and Wetlands Statement of Findings - Remedial Action at the Shiprock Uranium Mill Tailings Site, Shiprock, New Mexico

Federal Register 49(133):28225-28228 (1984, July 10)

This is a Statement of Findings, prepared pursuant to Executive Orders 11988 and 11990, and 10 CFR 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements. Pursuant to the Uranium Mill Tailings Radiation Control Act 1978 (Public Law 95-604, enacted November 8, 1978), the U.S. Department of Energy (DOE) proposes to clean up the residual radioactive wastes and other contaminated materials at the inactive uranium mill tailings site located on the Navajo Indian Reservation at Shiprock, New Mexico. The proposed remedial action will move and stabilize the radioactive wastes according to a plan to be concurred in by the U.S. Nuclear Regulatory Commission and the Navajo Tribe. (JWF)

439

Mares, J.W., U.S. Department of Energy, Washington, DC

Finding of No Significant Impact, Remedial Action at the Shiprock Uranium Mill Tailings Site, Shiprock, NM

Federal Register 49(213):44008-44011 (1984, November 1)

The U.S. Department of Energy (DOE) has prepared an environmental assessment (DOE/EA-0232) on the proposed remedial action at the inactive uranium mill tailings site located on the Navajo Indian Reservation at Shiprock, New Mexico. Based on the analysis in the EA, DOE has determined that the proposed action does not constitute a major federal action significantly affecting the quality of the human environment. within the meaning of the National Environmental Policy Act of 1969 (NEPA) (U.S. Code 42:4321 et seq.). (JWF)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

440

Meyer, H.R., D.J. Skinner, and D. Charlton, Chem-Nuclear Systems, Inc., Albuquerque, NM

Environmental Radiological Assessment in the UMTRA Program

Health Physics 47(1):202; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

Due to need for compliance with a variety of federal, state and Indian Tribe regulations and requirements, planning for environmental protection within the Uranium Mill Tailings Remedial Action Program (UMTRA) has been and will continue to be a complex process. Initial remedial action at the Canonsburg, Pennsylvania site indicates that compliance with standards for public exposure to radon gas, radon daughters, airborne particulate radionuclides, and radionuclides dissolved or suspended in water can be met during cleanup operations. As greater quantities of mill tailings material are exposed and handled at Canonsburg, however, careful attention to monitoring and control of environmental releases becomes necessary. Morrison-Knudsen Corporation and Chem-Nuclear Systems, Inc., jointly acting as the Remedial Action Contractor (RAC), are responsible to the U.S. Department of Energy for performing actual cleanup and radiological activities at UMTRA sites and many associated vicinity properties. The purpose of this paper is to present the RAC's current interpretation of applicable standards and requirements, the methods and instruments being employed at Canonsburg to monitor and control emissions and concentrations of radionuclides, and a summary of pertinent local data acquired recently. Also, because the UMTRA Program is one of the largest long-term health physics activities currently underway, an important purpose of the presentation is to encourage comments and suggestions concerning the UMTRA health physics procedures being employed by the RAC. (Auth)

441

Nielson, K.K., and V.C. Rogers, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Field Evaluation of Uranium Mill Tailings Covers: A 20-Year Case Study

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 283-292) (1985)

A field evaluation of the four tailings piles at the Monticello, Utah uranium mill site is used to assess the performance of simple containment systems for uranium mill tailings after twenty years performance. Although the physical integrity of the tailings containment is intact and well-vegetated, evidence of salt and radium migration and biological uptake is apparent. It appears that most of the deficiencies in radiological containment observed at Monticello are overcome by present designs that require thicker covers and better hydrologic control. (Auth)

442

Olsen, K.B., and V.W. Thomas, Pacific Northwest Laboratory, Richland, WA

Borehole Logging for Radium-226: Recommended Procedures and Equipment, Final Report

NUREG/CR-3429; 43 pp. (1984, October)

Field investigations and a literature review were conducted to determine whether existing well-logging techniques are suitable for measuring Ra-226 at remedial action sites. These methods include passive gamma-ray measurement techniques using NaI(Tl) and, occasionally, intrinsic germanium detectors. Parameters that must be considered when logging boreholes at remedial action sites include: (1) casing material and thickness, (2) water in the borehole, and (3) distribution of the tailings material. Information from the uranium exploration industry demonstrates that borehole logging is a better method for estimating radionuclide concentrations in subsurface soils than core and drill cutting analysis. Field measurements using NaI(Tl) and IG detectors at Edgemont, South Dakota, have shown that NaI(Tl) detectors log boreholes faster than IGs. However, if NaI(Tl) detectors are used, additional time is required after logging to obtain representative samples of any anomalies found during logging, conform those samples to a constant geometry, and then count the samples using IG detectors to determine if the materials are tailings.

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

443
Price, J.B., and G. Rice, Sergent, Hauskins and Beckwith Geotechnical Engineers, Inc., Albuquerque, NM

Uranium Isotope Distribution in Ground Water at the Shiprock Mill Site

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 189-198) (1985)

Uranium is the most mobile of the radioactive elements which are found in groundwater at the Uranium Mill Tailings Remedial Action (UMTRA) Project former milling sites. In most natural groundwaters there is an approximately equal distribution between the radioactivity of the U-234 and U-238 isotopes of uranium. The milling process and the decay chain of uranium can increase or decrease the ratio of U-234/U-238 in groundwater near milling sites. The areal distribution of U-234/U-238 in aqueous form is examined for the Shiprock, New Mexico tailings as a possible tool for characterizing groundwater. (Auth)

444
Rogers, V.C., K.K. Nielson, G.M. Sandquist, and D.C. Rich, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Radon Flux Measurements and Computational Methodologies

UMTRA-DOE/AL-2700.201; 56 pp. (1984, June)

A detailed review has been performed of present technology for radon flux measurement and calculation methods. The review concentrates on technology which was utilized under the Uranium Mill Tailings Remedial Action Project and which is available for future remedial action design applications. Five main radon flux measurement methods are evaluated: the accumulator can, a small charcoal sampler, a large-area charcoal sampler, the "Big Louie" charcoal sampler, and the charcoal tent sampler. These sampling methods are evaluated with respect to their theoretical maximum sampling times and equations are given to allow predictions of maximum sampling times if any of these samplers are modified. Mathematical methods for predicting radon fluxes are deemed adequate both for remedial action design problems and for more complicated numerical simulations of climatological effects, sampler design problems, and other applications. One-dimensional, steady-state diffusion codes with multi-region capabilities are suitable for most applications and utilize rapid analytical solutions to the diffusion equations. Finite-difference methods are required for most cases of greater complexity, and these have been developed for various time-dependent cases of 1-, 2-, and 3-dimensional diffusion. (Auth)

445
Schoenfelder, R.P., P.W. Zelle, and K.R. Baker, Weston (Roy F.), Inc., Albuquerque, NM

Radiological Characterization Requirements for Planning Remedial Action at UMTRA Project Sites

Health Physics 47(1):139; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

Twenty-four inactive uranium processing sites are designated for remedial action under the Uranium Mill Tailings Remedial Action (UMTRA) Project. An extensive radiological site characterization effort is underway to obtain the data necessary to design the remedial action. This includes data for determining the pile radium-226 content and distribution, the emanation fraction of tailings, the diffusion coefficients of tailings and cover material, and the contaminant distribution in former processing areas and nearby areas contaminated by wind or water transport. For building surveys, measurements are taken for surface contamination, gamma-ray exposure rate, and radon daughter concentration. All data are recorded relative to a reproducible reference that spans the tailings pile, buildings, and nearby open lands. The radium-226 content of the piles is determined by gamma spectroscopy analyses of core samples taken from the holes drilled at a density of approximately one per acre. For open lands adjacent to the pile, gamma-ray exposure rate measurements are made to delineate the approximate boundary of the off-pile contamination. A combination of gamma-ray well logging, soil sampling, and in-situ gamma analyses techniques are used to carefully define the depth and areal extent of the contamination. Two different plans exist for surveying buildings, one plan for structures to be demolished, and another for those to be decontaminated. The details of the development and implementation of the site characterization plan is presented. (Auth)

446

Shay, R.S., and S.M. Rush, Bendix Field Engineering Corporation, Grand Junction, CO

Radiologic Characterization of the Lakeview, Oregon, Uranium Mill Tailings Remedial Action Site

GJ-20; 118 pp. (1984, September)

The objective of the radiologic characterization of the inactive uranium millsite at Lakeview, Oregon, was to determine the horizontal and vertical extent of radioactive contamination that exceeds Environmental Protection Agency standards. The data presented in this report are required for characterization of the tailings pile and for identification and design of cleanup activities in areas adjacent to the pile. (Auth)

447

Stieff, L.R., Stieff Research and Development Company, Inc., Kensington, MD

The Characterization of Uranium Mill Tailings Using Alpha-Sensitive Nuclear Emulsions

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 559-568) (1985)

Alpha-sensitive nuclear-emulsion techniques have been used for the first time to supplement the traditional bulk chemical and radiometric measurements of uranium, radium, radon, and other radionuclide concentrations in uranium-mill-tailings samples. The work was undertaken in an effort to characterize the way these radionuclides are distributed, i.e. their modes of occurrence, mineralogy, and relative mobility. This preliminary investigation involved approximately 40 samples of drill core from the four tailings piles at the Monticello Mill, Monticello, Utah. The micro-autoradiographic technique that was used permits the direct observation of the alpha activity of uranium, Th-230, Ra-226, Rn-222, and some of the other alpha-emitting daughter products, as well as the association of these radionuclides with mineral grains and particles in the samples. These nuclear-emulsion studies suggest that there are four principal modes of occurrence involving U-238, U-234, and Th-230; and four principal modes of occurrence of Ra-226 and its immediate daughters Rn-222, Po-218, and Po-214. The qualitative, descriptive information on the localization of these radionuclides suggests that subsequent nuclear-emulsion studies combined with detailed mineralogical studies would contribute in several important ways to the uranium mill-tailings remedial program. These contributions might include: (1) specific remedial actions based on the modes of occurrence of Ra-226 and Th-230; (2) assessment of both short-term and long-term effectiveness of certain remedial actions; and (3) procedures to minimize further movement of Ra-226 and Rn-222 within tailings piles. (Auth)(DCM)

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, La Plata County, Colorado - Draft Environmental Impact Statement: Volume 1 - Text

DOE/EIS-0111D (Vol.1); 256 pp. (1984, October)

This statement evaluates the environmental impacts associated with the remedial actions of the residual radioactive materials remaining at the inactive uranium processing site located in Durango, La Plata County, Colorado. The site is a 126-acre tract of privately owned land which contains about 1.6 million cubic yards of contaminated materials including 1.2 million cubic yards of uranium and vanadium tailings. The tailings were produced by the former United States Vanadium Corporation from 1943 to 1946, and by the Vanadium Corporation from 1943 to 1946, and by the Vanadium Corporation of America from 1949 to 1963. Vanadium tailings and uranium ore were processed for sale to the U.S. Atomic Energy Commission until the mill was closed in 1963. Five alternatives are considered in this statement. These alternatives are: (1) no action, (2) stabilize the contaminated materials on the Durango site, (3) transport the contaminated materials to the Bodo Canyon site for disposal and decontaminate the Durango site, (4) transport the contaminated materials to the Long Hollow site for disposal and decontaminate the Durango site, and (5) transport, reprocess, and dispose of the tailings at the Long Hollow site and decontaminate the Durango site. An assessment of the impacts of these five alternatives was made in terms of effects on radiation levels, air quality, soils and mineral resources, surface water and ground water resources, population, employment, economic structures, and transportation networks. A summary table of the impacts is given.

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, La Plata County, Colorado - Draft Environmental Impact Statement: Volume 2 - Appendices

DOE/EIS-0111D (Vol.2); 614 pp. (1984, October)

Volume II contains the following appendices: Conceptual designs and engineering evaluations for remedial alternatives; Vicinity-property remedial actions; Alternatives that were considered but rejected; Meteorological and air-quality information; Soils, geologic, and seismic information; Water resources information; Ecological information; Radiological information; Information on populations, socioeconomics, and land use; Floodplain and wetlands assessment, and; List of agencies, organizations, and persons receiving copies of this statement.

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U.S. Department of Energy, Albuquerque Operations Office, Office of Public Affairs, Albuquerque, NM

DOE Conducts Studies at Lakeview Tailings Site

DOE News (July 31, 1984):1 (1984, July 31)

The U.S. Department of Energy is in the process of collecting data relative to the inactive uranium mill tailings site near Lakeview, Oregon. Radiological, ground water, and geotechnical studies are being performed in order to prepare for remedial action at the tailings site. The data obtained will be incorporated into an environmental report assessing the suitability of the alternate sites for long-term disposal of the Lakeview tailings. (ARE)

451
U.S. Department of Energy, Washington, DC

Compliance with the National Environmental Policy Act, Intent to Prepare an Environmental Impact Statement and Conduct Public Scoping Meetings for Remedial Actions at the Inactive Uranium Mill Tailings Site and Vicinity Properties in and near Durango, Colorado

Federal Register 46(109):30383-30385 (1981, June 8)

The U.S. Department of Energy (DOE) announces its intent to prepare an EIS in accordance with Section 102(2)(c) of the National Environmental Policy Act (NEPA), to provide environmental input into the selection of an appropriate strategy for the permanent disposal of the uranium mill tailings at the site of a now-dismantled uranium mill formerly owned by the Vanadium Corporation of America and at associated vicinity properties in and near Durango, Colorado. The DOE is currently considering as its proposed action the removal of the tailings to a specially prepared remote site for permanent disposal. (JWF)

452
U.S. Department of Energy, Washington, DC

Announcement of Availability of Environmental Assessment, and Publication of Proposed Findings of No Significant Impact, Remedial Action at the Shiprock Uranium Mill Tailings Site, Shiprock, New Mexico

Federal Register 49(133):28224-28225 (1984, July 10)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM ENVIRONMENTAL STUDIES AND SITE SURVEYS

The U.S. Department of Energy (DOE) has prepared an Environmental Assessment (DOE/EA-0232) on the proposed remedial action at the inactive uranium mill tailings site located on the Navajo Indian Reservation at Shiprock, New Mexico. Based on the analysis in the EA, a proposed finding of no significant impact has been prepared. The EA and proposed findings are being made available for public review; the public review period will close August 9, 1984. Following completion of the public review period, DOE will make its final determination whether to prepare an Environmental Impact Statement. (JWF)

453
U.S. Department of Energy, Washington, DC

Announcement of Availability of Final Environmental Impact Statement, Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah

Federal Register 49(149):30773-30774 (1984, August 1)

The U.S. Department of Energy (DOE) has prepared a final Environmental Impact Statement (DOE/EIS-00990-F) on the remedial actions at the inactive uranium milling site (Vitro site) located in South Salt Lake, Salt Lake county, Utah. The EIS is being made available for public review; the public review period will close 30 days after publication of the notice of availability of the EIS. Following completion of the public review period, DOE will issue its Record of Decision. (JWF)

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U.S. Department of Energy, Washington, DC

Notice of Intent To Prepare an Environmental Assessment and Conduct Public Scoping Meetings for Remedial Actions at the Inactive Uranium Mill Tailings Site at Lakeview, OR

Federal Register 49(192):38976-38979 (1984, October 2)

The U.S. Department of Energy (DOE) announces its intent to prepare an environmental assessment (EA) in accordance with Council on Environmental Quality regulations 40 CFR 1508.9 to provide environmental input into the selection of appropriate remedial action in connection with uranium mill tailings and other residual radioactive materials at the inactive mill, vicinity properties, and open lands contaminated by tailings, in Lakeview, Oregon. The DOE's proposed action is to perform remedial action pursuant to Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978. (JWF)

455
U.S. Department of Energy, Washington, DC

Availability of Draft Environmental Impact Statement (DEIS) and Public Hearing on the DEIS - Uranium Mill Tailings Remedial Action at Durango, CO

Federal Register 49(223):45481-45483 (1984, November 16)

The U.S. Department of Energy (DOE) has published a draft environmental impact statement (DEIS), DOE/EIS-0111-D, Remedial Actions at the Former Vanadium Corporation of America mill site, Durango, La Plata County, Colorado (October, 1984) for a proposed DOE action to perform remedial actions on residual radioactive material at the inactive uranium mill in Durango, Colorado. Written comments are invited and a public hearing will be held with respect to the DEIS. (JWF)

456
U.S. Department of Energy, Washington, DC

Announcement of Availability of Environmental Assessment, Remedial Actions at the Former Lakeview Mining Company Mill Site, Lakeview, Lake County, OR

Federal Register 50(97):29826-20827 (1985, May 20)

The U.S. Department of Energy (DOE) has prepared an environmental assessment (DOE/EA-0271) on the remedial actions at the former uranium mill site located north of Lakeview, Lake County, Oregon. The environmental assessment (EA) is being made available for public review; the public review period will close 30 days after publication of the May, 20, 1985 notice. Following completion of the public review period, DOE will make its determination whether to prepare an Environmental Impact Statement. (JWF)

457

White, A.F., J.M. Delany, T.N. Narasimhan, and A.R. Smith, Lawrence Berkeley Laboratory, Berkeley, CA

Groundwater Contamination from an Inactive Uranium Mill Tailings Pile, 1: Application of a Chemical Mixing Model

Water Resources Research 20(11):1743-1752 (1984, November)

Low-pH process waters contained in a number of inactive and abandoned uranium mill tailings piles in the United States represent potential sources of radionuclide and trace metal contamination of groundwater. Detailed investigations at a typical site at Riverton, Wyoming, indicate that chemical transport occurs from initial dewatering of the tailings, downward infiltration due to precipitation, and groundwater intrusion into the base of the tailings pile. Except for elevated uranium and molybdenum concentrations, current radionuclide and trace element transport is limited by the near-neutral pH conditions of the groundwater. Significant reactions include the dissolution of calcite, production of CO_2, and precipitation of gypsum and the hydroxides of iron and aluminum. A geochemical mixing model employing the PHREEQE computer code is used to estimate current rates of the groundwater contamination by tailings water. A maximum mixing of 1.7% of pore water is a factor of 2 less than steady state estimates based on hydraulic parameters. (Auth)

458

Whitfield, M.S., Jr., W. Thordarson, W.J. Oatfield, E.A. Zimmerman, and B.F. Rueger, U.S. Geological Survey, Lakewood, CO

Regional Hydrology of the Blanding-Durango Area, Southern Paradox Basin, Utah and Colorado

USGS-WRIR-83-4218; 124 pp. (1983)

Principal findings of this study that are pertinent to an assessment of suitability of the hydrogeologic systems to store and contain radioactive waste in salt anticlines of adjacent areas are: water in the upper ground-water flow system discharges to the San Juan River - a major tributary of the Colorado River. Discharge of water from the upper aquifer system to streambed channels of the San Juan River and its tributaries during low-flow periods primarily is through evapotranspiration from areas on flood plains and maintenance of streamflow; the lower ground-water system does not have known recharge or discharge areas within the study area; subsurface inflow to this system comes from recharge areas located north and northeast of the study area; the upper and lower ground-water systems are separated regionally by thick salt deposits in the Blanding-Durango study area of the Paradox basin; potential exists in mountainous areas for downward leakage between the upper and lower ground-water systems, where salt deposits are thin, absent, or faulted; no brines were found in this study area with outflow to the biosphere; water in the upper ground-water system generally is fresh. Water in the lower ground-water system generally is brackish or saline; and ground-water flow disruptions by contiguous faults probably are common in the upper ground-water system. These disruptions of flow are not apparent in the lower ground-water system, perhaps because available hydrologic data for the lower ground-water system are scarce. The above major findings do not preclude the potential for waste storage in salt; however, they do not allow the prediction of detailed ground-water flow rates and directions through this area.

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Zelle, P.W., R.P. Schoenfelder, and K.R. Baker, Weston (Roy F.), Inc., Albuquerque, NM

Radiological Characterization Requirements for Planning Remedial Action at UMTRA Project Sites

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 243-252) (1985)

Twenty-four inactive uranium processing sites are designated for remedial action under the Uranium Mill Tailings Remedial Action (UMTRA) Project. An extensive radiological site characterization effort is underway to obtain the data necessary to design the remedial action. This includes data for determining the pile radium-226 content and distribution, the radon emanating fraction of tailings, the radon diffusion coefficients of tailings and cover material, and the contaminant distribution in former processing areas and nearby areas contaminated by wind or water transport. The radium-226 content of the piles is determined by gamma spectroscopy analyses of core samples taken from holes drilled at a density of approximately one per acre. For open lands adjacent to the pile, gamma-ray exposure rate measurements are made to delineate the approximate boundary of the off-pile contamination. A combination of gamma-ray downhole-logging, soil sampling, and in-situ gamma-ray analyses techniques are used to carefully define the depth and areal extent of the contamination. Two different plans exist for surveying buildings, one plan for structures to be demolished, and another for those to be decontaminated. For building surveys, measurements are taken for surface alpha contamination, gamma-ray exposure rate, and radon daughter concentration. All data are recorded relative to a reproducible reference grid that spans the tailings pile, buildings, and nearby open lands. The details of the development and implementation of the radiological characterization plan for off-pile contamination are presented. (Auth)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM HEALTH, SAFETY, AND BIOMEDICAL STUDIES

460

Coffman, J.H., H.R. Meyer, D.J. Skinner, and D. Charlton, Chem-Nuclear Systems, Inc., Albuquerque, NM

Preparation and Implementation of a Radiological Health and Safety Program for the Uranium Mill Tailings Remedial Action Program

Health Physics 47(1):139; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

In 1978, Congress passed Public Law 95-604 establishing 24 inactive mill sites containing uranium mill tailings which may pose a potential health hazard to the public. The U.S. Environmental Protection Agency promulgated remedial action standards for this uranium mill tailings program on March 7, 1983. Morrison-Knudsen Company, Inc. was chosen as the remedial action contractor and Chem-Nuclear Systems, Inc., as the radiological health and safety subcontractor. A health and safety plan was developed and implemented to support the field construction activities which began in Canonsburg in October, 1983. The plans developed are discussed as well as problems encountered and lessons learned. The field soil sampling method used to meet the EPA standards for unrestricted use (5 pCi/g) is described and field experience discussed. (Auth)

461

Marks, S., D.H. Denham, F.T. Cross, and W.E. Kennedy, Jr., Pacific Northwest Laboratory, Richland, WA

Health Effects Estimation for Contaminated Properties

PNL-SA-10992; CONF-840512; Proceedings of the Sixth International Radiation Protection Association Congress, Berlin, Federal Republic of Germany, May 7, 1984 (1984)

As part of an overall remedial action program to evaluate the need for and institute actions designed to minimize health hazards from inactive tailings piles and from displaced tailings, methods for estimating health effects from tailings were developed and applied to the Salt Lake City area.

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Rogers, V.C., and G.M. Sandquist, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Lung Cancer Risks in the Vicinity of Uranium Tailings Sites

UMTRA-DOE/ALO-183; 48 pp. (1982, April)

Lung cancer mortality data have been assembled for many counties of interest to the Uranium Mill Tailings Remedial Action Program (UMTRAP). The counties generally either contain UMTRAP tailings sites or are adjacent to them. The lung cancer rates of nearly all counties are less than the U.S. average rate. A value of 150 lung cancer deaths per million per WLM was used in the study. In addition, some of the factors associated with lung cancer are identified, as are risk estimators for radon daughters. (Auth)(JWF)

463

Talbott, E.O., E.P. Radford, P.A. Murphy, R. Schmeltz, L. Kuller, C. Portocarrero, R. Doll, and N. Traven, University of Pittsburgh, Center for Environmental Epidemiology, Pittsburgh, PA

Health Effects in a Community Exposed to Low-Level Radiation - Distribution of Thyroid Abnormalities in a Community Exposed to Gamma Radiation from a Uranium Waste Site

Technical Report 84-9; 21 pp. (1984, August)

Since 1910, a uranium waste site has been located directly adjacent to the communities of Strabane and Canonsburg, Pennsylvania (18 miles southwest of Pittsburgh). The waste site is located in an area now known as the Canon Industrial Park, where uranium was processed from 1910-1958. At the request of the U.S. Department of Energy, radiological surveys of the site were conducted during the period of March to July 1977. Off-site aerial radiometric measurements taken over a one-mile by 2.5 mile area indicate a background of 3-7 uR/hr with elevated gamma radiation levels of 9-50 uR/hr within a 1/3-1/4 mile radius of the plant. In addition to the radiation exposure from the plant and waste site, residents have been exposed by way of contaminated articles (bricks, boards, landfill) which were removed from the plant over a 50-year period. Much of this material has found its way into the homes of the residents. Off-site radiometric measurements taken in Strabane and Canonsburg indicate there are over 100 homes with localized areas of increased radioactivity. Because of this situation, DOE and EPA conducted an off-site monitoring effort. The average gamma radiation level at 1 meter measured on private property bordering the site was 22 uR/hr. Given the low-dose nature of the exposures and the relative ease with which a head and neck exam could be performed, it was decided to conduct a community wide survey of the prevalence of thyroid disease, particularly nodular thyroid conditions. Current residents 21 years or older living within the area for 15 years or more comprised the study group. Residents of same age and residence criteria in Muse, a town 5 miles away, served as a control. A total of 514 individuals were screened (180 men and 334 women). The average length of residence or exposure was 35.5 years in Strabane versus 32.0 years in the control group. There were no differences with regard to distribution of total thyroid disease in men and women in Strabane/Canonsburg compared to Muse (18.2% versus 21.0%). Poor participation and follow-up of the men and an inability to verify work histories in the Industrial Park precluded further analysis of this group. Among women, the rate of total thyroid disease was similar for the two groups (25.4% versus 26.8%). However, in exposed females, the rate of possible radiation-related thyroid disease (nodule, adenoma and carcinoma) was twice that in nonexposed females (7.6% versus 3.3%). Data for women were stratified by length of residence in their respective community (less than 35 years or 35 or more years). The ratio of disease in the less than 35-year group was similar (4.5/100 versus 3.7/100) but for those with 35 or more years of residence the rate was 11.7/100 in Strabane/Canonsburg and 3.0/100 in the control community. This is a borderline significant effect which might be expected given the low-level nature of the exposure. (Auth)(DCM)

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U.S. Environmental Protection Agency, Washington, DC

Code of Federal Regulations, Title 40, Part 192 - Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

Code of Federal Regulations, Title 40, Protection of the Environment, Parts 190 to 399, Revised July 1, 1984; (pp. 7-14) (1984, July 1)

Part 192 consists of the following standards: (1) Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites; (2) Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites; (3) Implementation; (4) Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended; and (5) Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended. (JWF)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM SITE STABILIZATION AND RECLAMATION

465

Beedlow, P.A., L.L. Cadwell, and M.C. McShane, Pacific Northwest Laboratory, Richland, WA

Design Surface Covers: An Approach to Long-Term Waste Site Stabilization

PNL-SA-11174; CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (p. 8) (1983, February)

The wide range of existing environmental conditions, potential contaminants, and available cover materials at waste disposal sites necessitates site-specific designing of surface covers for effective long-term erosion resistance. This paper presents a systematic approach to designing surface covers for hazardous waste repositories that can be tailored to conditions at any site. The approach consists of three phases: (1) an assessment, during which the degree of required surface protection (erosion potential) is determined; (2) a preliminary design that integrates surface cover design with the need to minimize transport of contaminants; and (3) a final design, where the cost and effectiveness of the surface cover are determined.

466

Gee, G.W., K.K. Nielson, and V.C. Rogers, Pacific Northwest Laboratory, Richland, WA

Predicting Long-Term Moisture Contents of Earthen Covers at Uranium Mill Tailings Sites

DOE/UMT-0220; PNL-5047; 46 pp. (1984, September)

The three methods for long-term moisture prediction covered in this report are: estimates from water retention (permanent wilting point) data, correlation with climate and soil type, and detailed model simulation. The test results have shown that soils vary greatly in residual moisture. Expected long-term moisture saturation ratios (based on generalized soil characteristics) range from 0.2 to 0.8 for soils ranging in texture from sand to clay, respectively. These values hold for noncompacted field soils. Measured radon diffusion coefficients for soils at 15-bar water contents ranged from 5.0 X 10(E-2) sq cm/s to 5.0 X 10(E-3) sq cm/s for sands and clays, respectively, at typical field densities. In contrast, fine-textured pit-run earthen materials, subjected to optimum compaction (greater than 85% Proctor density) and dried to the 15-bar water content, ranged from 0.7 to 0.9 moisture saturation. Compacted pit-run soils at these moisture contents exhibited radon diffusion coefficients as low as 3.0 X 10(E-4) sq cm/s. The residual moisture saturation for cover soils is not known since no engineered barrier has been in place for more than a few years. A comparison of methods for predicting moisture saturation indicates that model simulations are useful for predicting effects of climatic changes on residual soil moisture, but that long-term moisture also can be predicted with some degree of confidence using generalized soil properties or empirical correlations based both on soils and climatic information. The optimal soil cover design will likely include more than one layer of soil. A two-layer system using a thick (1-m minimum) plant root zone of uncompacted soil placed over a moistened, tightly compacted, fine-textured soil is recommended. This design concept has been tested successfully at the Grand Junction, Colorado tailings piles.

467

Keshian, B., M. Bone, and T. Schruben, Weston (Roy F.), Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM

Design of Erosion Protection for Long-Term Stability

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 163-173) (1985)

The dissipation of radon gases from uranium mill tailings piles is a major concern in the reclamation of existing tailings piles. In order to dissipate the gases before they escape into the atmosphere, the tailings will be covered with 3 to 10 feet of clays, silts, sands, or varying mixtures of the three. The type and thickness of material used will depend on the borrow material available in close proximity to the site as well as the physical properties of the material. In the design of these radon barriers, it is extremely important that the integrity of the barrier be maintained for the design life of the facility (1000 years). One of the processes which threatens the integrity of the barrier is water erosion resulting from flood inundation or on-site rainfall runoff. To protect against potentially destructive erosional forces, a rock cover has been incorporated into the design. This paper presents the design procedures for specifying rock erosion protection that will be used for the remedial action at the UMTRA Project sites. These procedures, which are to ensure consistent designs from one site to another, have been adopted after a careful review of existing literature and design procedures and incorporate state-of-the-art methodology. (Auth)(DCM)

468

Pakalnis, R., G. Chedsey, A.M.G. Robertson, and S. Follin, Pakalnis and Associates, Denver, CO; Robertson and Kirsten, Inc., Lakewood, CO

Vacuum Horizontal Drainage for Depressurization of Uranium Tailings

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 549-558) (1985)

A recent advance in tailings slope depressurization is the application of vacuum assist horizontal drainage. Horizontal drains have been used for several decades to reduce water pressures in slopes in order to improve stability. The benefit from vacuum assist arises from an increased hydraulic gradient caused by induced negative atmospheric pressures. The vacuum assist system has, since its inception in 1982, been successfully employed at two soil and four rock slope projects located in Western Canada. This paper describes the first application of this system in the United States. The technical feasibility of employing vacuum assisted horizontal drains to depressurize a uranium tailings dam near Riverton, Wyoming has been evaluated. Two 300-ft-long horizontal drains were installed and their effect monitored by nine piezometers. The study was conducted over a three-week interval with vacuum being applied for three- and four-day periods. The drawdown achieved through vacuum drainage was found to be approximately double that obtained by gravity alone. The volume of water exhausted under vacuum during the seven-day interval was approximately double that obtained by gravity alone. (Auth)(DCM)

469

Rogers, V.C., and K.K. Nielson, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Uncertainty Analysis for Uranium Mill Tailings Cover Design

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 293-299) (1985)

It is often desirable to evaluate the degree of confidence associated with a particular uranium mill tailings cover design in order to have a reasonable assurance that the design will provide sufficient radon control. A methodology for performing an uncertainty analysis of cover designs for radon control and a data base containing the key parameters influencing cover design are presented. A sample analysis with representative data reveals an uncertainty of about a factor of two in cover thickness. (Auth)(DCM)

470

Smith, W.J., Jr., and M. Jackson, Weston (Roy F.), Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM

Radon Barrier Designs for the UMTRA Project

Health Physics 47(1):140; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

The design requirement set by the U.S. Environmental Protection Agency for radon releases from inactive uranium mill tailings piles after remedial action is to provide reasonable assurance that releases of radon-222 from residual radioactive materials to the atmosphere will not: (1) exceed an annual average release rate of 20 pCi/sq m/s; or (2) increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than 0.5 pCi/l. The current earthen cover radon barrier design concepts for satisfying this requirement are described. The site-specific data required for the barrier design are discussed, including the properties of the tailings and the various cover materials. The design procedures are outlined and the calculations are illustrated by examples from several sites. An estimate of the costs of the radon barrier is provided. (Auth)

471

Smith, W.J., Jr., R.A. Nelson, and K.R. Baker, Weston (Roy F.), Inc., Albuquerque, NM; Jacobs Engineering Group, Inc., Albuquerque, NM

Sensitivity Analysis of Parameters Affecting Radon Barrier Cover Thickness

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 209-219) (1985)

The sensitivity analysis summarized in this paper was made to determine the parameters of greatest influence in the prediction of radon barrier cover thickness for the stabilization of uranium mill tailings piles. Such information provides the basis for setting priorities and levels of effort for data collection, and improves knowledge of the sources of uncertainty in the calculation of cover thickness. In the context of this paper, the influence of a parameter on cover thickness incorporates two effects: (1) the sensitivity of the mathematical formulation to changes in a parameter's value, and (2) the range of values that a parameter may take on under site-specific conditions. Of the several parameters that are used in the calculations, the most influential are cover moisture content, cover radon diffusion coefficient, tailings radium concentration and tailings radon emanating fraction, in order of decreasing relative influence. Less influential parameters for typical conditions are the tailings pile thickness and tailings radon diffusion coefficient. Some parameters are influenced by others; for example, cover or tailings radon diffusion coefficients are influenced by the moisture content and porosity of the material. The effects of such dependencies are discussed. (Auth)

472

Thiers, G.R., L.L. Farnes, and T.R. Wathen, International Engineering Company, Inc., San Francisco, CA; Morrison-Knudsen Company, Inc., Canonsburg, PA

Construction Experience at the Canonsburg UMTRA Site

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 233-242) (1985)

Construction of on-site stabilization for over 225,000 cubic yards of abandoned uranium mill tailings in Canonsburg, Pennsylvania began in October 1983, and is scheduled to be completed in December 1985. The significant construction events that have occurred through October 1984 are described. The selected events and construction items discussed are: (1) construction and operation of a 36,000-square foot, fabric-lined sedimentation basin, including difficulties associated with installation of the liner; (2) assembly and start-up of the contaminated water treatment plant; (3) construction of the encapsulation cell test fills, to confirm the performance specification governing the compaction; (4) excavation, relocation, and placement of contaminated materials, including moisture control and density testing of the radioactive materials; and (5) construction difficulties, including disposition of local leachate from the abandoned industrial complex and an increase in the volume of contaminated material to be encapsulated. (Auth)(DCM)

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

Fact Sheet on Salt Lake City Uranium Mill Tailings Site, Salt Lake City, Utah - Draft Environmental Impact Statement Summary

DOE News (January 1983):1-2 (1983, January)

This bulletin discusses the draft environmental impact statement (DEIS) for compliance with the U.S. Environmental Protection Agency (EPA) standards for the cleanup of inactive uranium mill tailing sites. The Vitro site in Salt Lake City, Utah, was designated as eligible for remedial action on November 8, 1979, by the U.S. Department of Energy. The DEIS examines three remedial action alternatives: (1) no action; (2) stabilization of all material at the Vitro site; and (3) decontamination of

the Vitro site and the transfer of all contaminated material to a new disposal site located 2 miles south of Clive, Tooele County, Utah. Estimated costs, in 1982 dollars, would be $25 million for alternative 2 and $61 million for alternative 3. (Auth)(PTO)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM WASTE DISPOSAL

474
Dinchak, W.G., Portland Cement Association, Skokie, IL

Liner Used in Tailings Ponds

World Mining Equipment 8(4):62-64 (1984, April)

A composite liner has been developed for use in hazardous waste impoundments and in tailings ponds where uranium is involved. The liner offers a high degree of reliability against seepage, is durable, and provides a firm working surface. The advantages of the liner are discussed.

475
Mueller, J.J., Controls for Environmental Pollution, Inc., Santa Fe, NM

Observed Reduction of Rn-222 Gas Emanation from Uranium Tailings Using a New Chemical Encapsulation Process

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (p. 54); Transactions of the American Nuclear Society 45:54 (1983)

One of the most controversial radiological contaminants in the environment is radon-222. Presently, uranium tailings (a major source of radon-222) are stored in confinement dams under several feet of liquid in order to contain the radon gas and eliminate its emission to the atmosphere. This method presents a hazard to the environment because of possible ground water contamination. It also creates a water resource problem in water-scarce areas. A method has recently been developed that contains and reduces radon-222 gas emanation from uranium tailings ponds. This method uses a chemical process in which radon-222 is encapsulated by solidification of uranium tailings slurry.

476
Taber, W.N., and D.J. Lechel, Weston (Roy F.), Inc., Albuquerque, NM

Alternate Site Selection Process for the UMTRA Project Site in Lakeview, Oregon

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 221-231) (1985)

The object of this study was to develop and implement an alternate site selection process for remedial actions at the Lakeview, Oregon, Uranium Mill Tailings Remedial Action (UMTRA) Project site. Requiring an alternate disposal site suitable for permanent (200-1000 years) storage of tailings and other wastes, a four-phased approach was implemented to evaluate and select two suitable sites. Phase I, Designation of a Search Region, identified criteria for selecting an initial study area and a minimum area to satisfy these criteria. A study area of approximately 700 square miles resulted from the Phase I effort. Phase II, Preliminary Screening of the designated Search Region, established geotechnical and environmental guidelines (Regional Screening Guidelines) to eliminate areas within the study area that were considered unsuitable for uranium tailings disposal. Application of the guidelines developed for Phase II reduced the study area from 700 square miles to approximately 70 square miles. Phase III, Preliminary Screening and Evaluation of Potential Areas, developed criteria considered desirable in selecting potential disposal sites and applied these criteria in the selection of six alternate areas. Results of this phase reduced the study area from 70 square miles to seven square miles. Phase IV, Identification and Evaluation of Candidate Sites, selected specific 40-acre parcels, developed a detailed rating matrix for each site, and ranked the selected sites in terms of overall suitability. The development of the site selection process and the application of the developed evaluation techniques are presented with the results of the program. (Auth)

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM REMEDIAL ACTION EXPERIENCE

477

Ball, D., D.J. McDonald, and W.C. Mason, U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM; Pennsylvania Department of Environmental Resources, Bureau of Radiation Protection, Harrisburg, PA; Weston (Roy F.), Inc., Albuquerque, NM

Site Cleanup Lessons Learned: Case Studies - Canonsburg

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

This paper presents a detailed description of the Canonsburg Industrial Park, the participation by the Commonwealth of Pennsylvania in the cleanup process, alternative waste disposal sites, site acquisition, remedial action standards, stabilization, radiation control, water quality protection, and project design and implementation. In implementing the site remedial actions, many challenging problems have arisen. Dealing with individuals and organizations in the area critical to the remedial action activities has been costly, requiring extensive man-hours and other resources. A nearby school had to be relocated. The acquisition of properties adjacent to the site was a potential problem which is being handled by the Corps of Engineers. These properties are being acquired so that the railroad right-of-way south of the site and the Chartiers Creek may act as natural barriers around the stabilized site. Construction has been delayed by wet weather. Special equipment is required for radon monitoring. It is also required to measure radium concentrations in soil to verify compliance with the applicable Environmental Protection Agency radium in soil standards. Consolidation of all project functions in the Albuquerque office has expedited implementation. Institutional requirements such as acquisition of properties, obtaining permits, execution of use agreements, development of environmental documents, and obtaining concurrence on remedial action plans should be started as soon as possible. Larger scale remedial action (construction) efforts are more cost effective. There are certain fixed costs which are required regardless of the magnitude of the construction effort. For the Canonsburg vicinity properties, the costs per property (24 properties) for remedial actions performed during the second year were about half the costs of the remedial action done during the first year when six properties were cleaned up. (ARE)

478

Donovan, T.K., E.J. Chart, J.T. Tappan, and G.W. Cummings, Tennessee Valley Authority, Knoxville, TN

Uranium Mill Decommissioning - An Update on the Edgemont Experience

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 159-163) (1983)

The Edgemont Uranium Mill decommissioning project has moved through the various regulatory and environmental phases and is ready to begin the final construction phase. In all, an estimated 5.4 million tons of contaminated material, including approximately 2.5 million tons of uranium mill tailings, will be moved to a disposal site approved by the U.S. Nuclear Regulatory Commission.

CHAPTER 5. URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM GENERAL STUDIES

479
Coffman, F.E., U.S. Department of Energy, Washington, DC

The Management of Radioactive Waste from Uranium Mining and Milling

IAEA-SM-262; STI/PUB-622; CONF-820552; Management of Wastes from Uranium Mining and Milling, Proceedings of an IAEA and OECD/NEA International Symposium, Albuquerque, NM, May 10-14, 1982. International Atomic Energy Agency, Vienna, 745 pp.; (pp. 3-6) (1982, May 10-14)

This keynote address gives a history of uranium mill tailings programs from World War II to the present.

480
Coobs, J.H., Oak Ridge National Laboratory, Oak Ridge, TN

Uranium Mill Tailings Program

ORNL/NFW-82/37; ORNL Nuclear Waste Programs Annual Progress Report for Period Ending September 30, 1982; (pp. 305-307) (1983, May)

The Uranium Mill Tailings Remedial Action Program (UMTRAP) is a national program dedicated to the cleanup and/or stabilization of 25 abandoned mill tailings sites in ten states. The program is administered for DOE by the Albuquerque Operations Office. Program participation by ORNL during FY 1982 consisted of two tasks: one on evaluation of liners for tailings piles and a second on information support for all aspects of the program. The liner technology task was intended to address the long- and short-term changes in properties of liner materials, but the scope of work was limited to an evaluation and assessment of grouted in-situ lines as a remedial action alternative. The second task provides information support to the program by maintaining a computerized data base, conducting searches of the data base as a service to users, preparing an annotated bibliography covering additions to the data base, and providing technical support at conferences.

481
Hillman, R.L., and D.E. Mohr, Weston (Roy F.), Inc., West Chester, PA; Weston (Roy F.), Inc., Albuquerque, NM

Technical Database and Management System (DBMS) for the UMTRA Project Processing Sites

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 179-198) (1985)

The technical DBMS is a structured and organized method for collecting, storing, retrieving, and analyzing technical data based upon standard operating procedures and quality control measures. The automated environment created by this design exists both as a repository for processing site technical data and the analysis techniques used against this data for site characterization, evaluation, and design. The system is composed of diverse technical subjects that are collectively used to address remedial action problems associated with mill tailings disposal. These technical subjects include hydrology, geology, geochemistry, radiology, and engineering. (Auth)

482
Matthews, M.L., U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

The Current Status of the Uranium Mill Tailings Remedial Actions Project

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 125-130) (1985)

In late 1978, Congress enacted Public Law 96-604, the "Uranium Mill Tailings Radiation Control Act of 1978." The act instructed the U.S. Department of Energy (DOE) to perform remedial actions at designated inactive uranium mill tailings sites. DOE established the Uranium Mill Tailings Remedial Actions (UMTRA) Project Office to implement remedial actions at the sites, in cooperation with the affected States, Indian tribes, U.S. Nuclear Regulatory Commission, and owners of the sites. The UMTRA Project Office began remedial actions at one of the sites in 1983, with an additional site started in late 1984, and two more planned in 1985. Numerous vicinity properties at four different site areas are also presently being cleaned up. All of this work is being performed in accordance with U.S. Environmental Protection Agency cleanup standards. (Auth)

483

Morley, J.A., U.S. Department of Energy. Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

The Uranium Mill Tailings Remedial Actions Project

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 165-168) (1982)

The Uranium Mill Tailings Radiation Control Act of 1978 directs the U.S. Department of Energy to undertake remedial actions at designated inactive uranium mill sites and associated vicinity properties. The purpose of the remedial actions is to stabilize and control the uranium mill tailings currently stored at the sites in a safe and environmentally sound manner in order to minimize radiation health hazards to the public. These remedial actions are to be undertaken by the DOE in cooperation with the affected states and Indian tribes and performed in accordance with standards promulgated by the U.S. Environmental Protection Agency. The disposal sites which could be the processing sites will be acquired by the states with title passing to the DOE and will be licensed by the U.S. Nuclear Regulatory Commission. The DOE's authorization to conduct the program terminates seven years following the promulgation of the EPA standards (January 19[illegible]). The current cost estimate for the project in 1982 dollars is $540 million. However, it is expected that this estimate will be somewhat reduced following completion of a review now in progress.

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Morley, J.A., and W.J. Arthur, U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

Overview and Status of the Uranium Mill Tailings Remedial Action Project

Health Physics 47(1):138; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

The Uranium Mill Tailings Remedial Action (UMTRA) Project was established by the Uranium Mill Tailings Radiation Control Act of 1978. The UMTRA Project has until March 1990 to complete remedial actions at 24 designated inactive uranium processing sites and at an estimated 7000 vicinity properties containing uranium mill tailings and other residual radioactive materials from the processing sites. All remedial action planning and designs are in accordance with standards promulgated by the U.S. Environmental Protection Agency in March 1983. The EPA standards required: (1) longevity of control, reduction in radon emissions, and protection of water quality at tailings piles; (2) reduction of gamma radiation and radon decay products in buildings; and (3) clean-up of radium contamination in soil. Remedial actions were initiated at Canonsburg, Pennsylvania, in October 1983. Remedial actions are planned to initiate at Salt Lake City, Utah, and Shiprock, New Mexico, in the summer and fall of 1984, pending completion of environmental documentation and NRC/DOE concurrence on remedial action plans. Key milestones in the remedial action process are site characterization, development of site conceptual design, environmental documentation, selection of disposal option, final design and specifications, remedial action construction, certification of completion of remedial actions, site licensing, and continued maintenance and surveillance. (Auth)

485

U.S. Congress, House of Representatives, Washington, DC

Management of Commingled Uranium Mill Tailings

Hearings Before the Armed Services Committee, United States House of Representatives, 97th Congress, August 17-18, 1982; 678 pp. (1982, August 17-18)

The U.S. Department of Energy (DOE) plan for the stabilization and management of commingled uranium mill tailings residue piles is assessed. Such piles result when residues from federal government milling contracts for uranium - primarily for defense purposes - are mixed with similar tailings from other milling activities. The plan is intended to detail fair share costs for government participation in any remedial action efforts required to protect public health and the environment. The cost effectiveness of covering, moving, and burying about 200 million tons of existing mill tailings to meet proposed NRC and EPA rules and standards to prevent several hypothetically predicted respiratory cancer deaths/yr is evaluated. DOE maintains the cost of implementing the revisions, estimated at $260 million, is too high. The potential danger of radon gas diffusing from piles is analyzed. (ENVIR)

486

U.S. Department of Energy, Office of Terminal Waste Disposal and Remedial Action, Washington, DC

Uranium Mill Tailings Remedial Action Program: Annual Status Report

DOE/NE-0025/3; 25 pp. (1984, December)

The Uranium Mill Tailings Remedial Action (UMTRA) Project's major accomplishments for FY 1984 are summarized. Twenty-five percent of the processing site remedial actions at Canonsburg, Pennsylvania were completed. Remedial action on 118 vicinity properties at four designated locations were initiated, and survey and inclusion activities on a total of 420 vicinity properties were completed. The Environmental Impact Statement (EIS) for Salt Lake City, Utah and the Environmental Assessment (EA) for Shiprock, New Mexico were published, and the preliminary draft EIS for Durango, Colorado was prepared. Remedial Action Plans (RAPs) for Salt Lake City, Utah and Shiprock, New Mexico were completed, and draft RAPs for Gunnison, Colorado and Riverton, Wyoming were prepared. Cooperative agreements with Oregon, Wyoming, and South Dakota were executed, and the Utah cooperative agreement was modified to assign the construction management responsibility to the state. An Interagency Agreement with TVA for disposal of the Edgemont vicinity property material was executed.

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U.S. Department of Energy, Washington, DC

Ineligibility of Inactive Uranium Mill Tailings Site for Remedial Action

Federal Register 46(239):60875 (1981, December 14)

Recent information from the state of Wyoming and the U.S. Department of the Interior pertaining to the eligibility of the inactive mill tailings site located in Baggs, Wyoming, under the provisions of section 101(6)(A) of the "Uranium Mill Tailings Radiation Control Act of 1978," has resulted in a determination by the U.S. Department of Energy that the Baggs site is on public lands under the jurisdiction of the Bureau of Land Management, U.S. Department of the Interior, and is, therefore, not eligible for remedial action by DOE. (JWF)

Chapter 5

URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM

- Design, Planning, and Regulations
- Environmental Studies and Site Surveys
- Health, Safety, and Biomedical Studies
- Site Stabilization and Reclamation
- Waste Disposal
- Remedial Action Experience
- General Studies

Chapter 6

GRAND JUNCTION REMEDIAL ACTION PROGRAM

CHAPTER 6. GRAND JUNCTION REMEDIAL ACTION PROGRAM

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Franz, G.A., Colorado Department of Health, Grand Junction Office, Grand Junction, CO

Site Cleanup Lessons Learned: Grand Junction Remedial Action Program

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The issues addressed by the Grand Junction Remedial Action Program are outlined. These include (1) identification of the problem, (2) defining the extent of and severity of the problem, (3) identifying locations needing remedial action, (4) developing remedial action program techniques and procedures, (5) refining these techniques and procedures, and (6) pragmatic nature of the program. This last phase includes local control of day-to-day activities, instrumentation limits dictating removal methods and procedures, and the needs of the public. (ARE)

489

Hazle, A.J., Colorado Department of Health, Denver, CO

Colorado's Remedial Action Experience

CONF-841105; Nuclear Power - A Global Reality, Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (p. 53); Transactions of the American Nuclear Society 47:53 (1984)

The paper briefly describes Colorado's involvement with the Grand Junction Remedial Action Program, the Uranium Mill Tailings Remedial Action Program, and the Superfund program. The lessons learned from the past 12 years of remedial action effort follow. (1) Measurements must be made with properly calibrated and maintained instruments with multiple reference source checks made during the day. All measurements must be made consistent with established procedures. Field data must be as complete as possible before developing the remedial action plan. (2) Total removal of all identified deposits is the preferred remedial action for ultimate resolution of the problem. All anomalies must be investigated and resolved. Investigate the potential for buried deposits. (3) A dedicated qualified field quality assurance team, not directly associated with design or construction implementation efforts, is essential to precluding having to redo remedial actions. (4) Mill tailings deposits over time are quite mobile in the sense that they "clandestinely" relocated. (5) Deposits in excess of the standards will remain within the community due to their hidden nature. Provision must be made for their proper future disposal. (6) While the net overall benefit to the community from such a facility may be positive, there is a negative impact from the time the problem is identified until the remedial action is completed even considering the economic benefit from the remedial action construction work. This is due to reluctance to site new industry in such a community and the reduction of tourism due to media coverage.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT DESIGN, PLANNING, AND REGULATIONS

490
AGPS, Canberra, Australia

Guidelines: Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores 1982 - Tailings Impoundment for Uranium Mines

Report; 60 pp. (1983)

This guideline is aimed at assisting users of the Code in siting, constructing, operating, decommissioning, and rehabilitating uranium tailings impoundments

491
Beedlow, P.A., G.W. Gee, J.F. Cline, W.H. Walters, and H.D. Freeman, Pacific Northwest Laboratory, Richland, WA

Determination of Compliance with Criteria for Final Tailings Disposal Site Reclamation

NUREG/CR-4076; PNL-5324; 38 pp. (1985, June)

This report provides methods and procedures that can be used to verify compliance with U.S. Environmental Protection Agency (EPA) engineering standards for uranium mill tailings disposal sites. EPA standards for radon emissions, long-term isolation, and protection of water quality are discussed. Tailings isolation technologies are reviewed. Information the licensee needs to provide for the regulating agency to determine compliance is presented, as is the actual compliance criteria. (Auth

492
Chilk, S.J., U.S. Nuclear Regulatory Commission, Washington, DC

Uranium Mill Tailings Regulations - Conforming NRC Requirements to EPA Standards

Federal Register 49(228):46418-46425 (1984, November 26)

The U.S. Nuclear Regulatory Commission (NRC) is proposing to amend its regulations governing the disposal of uranium mill tailings. The proposed rule changes are intended to conform existing NRC regulations to the regulations published by the U.S. Environmental Protection Agency for the protection of the environment from these wastes. This action is being taken to comply with the legislative mandate set out in the Uranium Mill Tailings Radiation Control Act and the NRC Authorization Act for FY 1983. The comment period expires January 10, 1985. (JWF)

493
Chilk, S.J., U.S. Nuclear Regulatory Commission, Washington, DC

Uranium Mill Tailing Regulations - Conforming NRC Requirements to EPA Standards

Federal Register 50(11):2293 (1985, January 16)

On November 26, 1984, (49 FR), the U.S. Nuclear Regulatory Commission (NRC) published for public comment a proposed rule amending its regulations governing the disposal of uranium mill tailings. The proposed changes are intended to conform existing NRC regulations to the regulations published by the U.S. Environmental Protection Agency. The comment period for this proposed rule was to have expired on January 10, 1985. A number of commenters have requested an extension of the comment period. In view of the importance of the proposed rule, and the desire of the Commission to allow all parties to fully express their views, the NRC has decided to extend the comment period for an additional thirty days. The extended comment period now expires on February 10, 1985. (JWF)

494
Chilk, S.J., U.S. Nuclear Regulatory Commission, Washington, DC

Uranium Mill Tailings Regulation - Ground Water Protection and Other Issues

Federal Register 50(11):2293 (1985, January 16)

On November 26, 1984 (49 FR), the NRC published for public comment an Advanced Notice of Proposed Rulemaking indicating that the NRC is considering further amendments to its uranium mill tailings regulations to

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT DESIGN, PLANNING, AND REGULATIONS

incorporate ground water protection provisions and other requirements established by EPA for similar hazardous wastes into NRC regulations. The comment period for this proposed rule was to have expired January 25, 1985. A number of commenters have requested an extension of the comment period. In view of the importance of the proposed rule, and the desire of the Commission to allow all parties to fully express their views, the NRC has decided to extend the comment period. The extended comment period now expires on March 1, 1985. (JWF)

495

Crawley, A.H.

Rehabilitation of Uranium Tailings Impoundments

CONF-8309275; Water Regime in Relation to Milling, Mining and Waste Treatment Including Rehabilitation with Emphasis on Uranium Mining, Proceedings of an International Specialist Conference, Darwin, Australia, September 4, 1983 (1983, September 4)

Under Australian environmental controls relating to the management of uranium tailings, it is no longer acceptable practice to search for a rehabilitation strategy at the end of production when the generation of tailings has ceased. The uranium projects currently in production and those being proposed are tightly regulated by the authorities. The waste management plans must consider site specific factors and must include selection of appropriate disposal sites and design for long-term containment. The final encapsulation in engineered facilities must take into account the probable routes to the environment of the tailings. Rehabilitation should be undertaken by the mining and milling operators to standards approved by appropriate authorities. Appropriate administrative arrangements are required, by way of technical committees and financial bonds, to ensure that agreed standards of rehabilitation may be achieved. Past and present experience with the rehabilitation of uranium tailings impoundments in Australia is discussed.

496

Uranium Mill Tailings Regulations - Ground Water Protection and Other Issues

Federal Register 49(228):46425-46428 (1984, November 26)

The U.S. Nuclear Regulatory Commission (NRC) is considering further amendments to its uranium mill tailings regulations. The future rulemaking contained in this article is primarily intended to incorporate ground water protection provisions and other requirements established by the Environmental Protection Agency for similar hazardous wastes into NRC regulation. This action is necessary to make NRC requirements similar to EPA standards as required by provisions of the Uranium Mill Tailings Radiation Control Act. (Auth)

497

Development of a Waste Management Program for a Uranium Mining/Milling Operation

Guidelines: Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores, 1982; Canberra:AGPS; 61 pp. (1982)

The Code requires the development of an approved waste management program prior to the commencement of a mining/milling operation. This guideline provides an overview of items to be addressed in developing an effective program. Basic principles are considered, data to be collected and analyzed are specified, major elements to be documented are listed and the development of an operation and maintenance manual is discussed. The program consists of all the facilities and procedures involved in the handling, treatment, storage and disposal of radioactive wastes together with relevant elements of radiation and other monitoring programs, contingency plans for unplanned events and proposals for decommissioning and rehabilitation.

498

Tailings Impoundment for Uranium Mines

Guidelines: Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores, 1982; Canberra:AGPS; 60 pp. (1982)

This guideline is aimed at assisting users of the Code in siting, constructing, operating, decommissioning and rehabilitating uranium tailings impoundments.

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499
EPA Opposes NRC Linkage of Mixed Waste, Mill Tailings in Draft MOU

Inside EPA 5(36):2-3 (1984, September 7)

The U.S. Environmental Protection Agency (EPA) plans to reject a proposal by the U.S. Nuclear Regulatory Commission (NRC) in a draft memorandum of understanding to couple uranium mill tailings agreements with agreements on how mixed hazardous and low-level radioactive wastes should be regulated. The EPA draft response to NRC's proposal reportedly justifies decoupling the two issues by stating that EPA and NRC are closer to a final agreement on uranium mill tailings than on the mixed waste issue, where the two agencies are clearly involved in a heated jurisdictional battle. (Auth)(CAC)

500
Kane, J.D., U.S. Nuclear Regulatory Commission, Washington, DC

Design, Inspection and Regulation of Uranium Mill Tailings Retention Facilities

CONF-820154; Geotechnics of Waste Management, Proceedings of the Society of Civil Engineers Conference, Philadelphia, PA, January 19, 1982 (1982)

The background of uranium mining and milling is briefly described, including the environmental and economic considerations in selecting the location of a uranium mill tailings retention facility. The role of the U.S. Nuclear Regulatory Commission in regulating uranium mill tailings facilities is briefly covered. Important engineering considerations that need to be addressed in developing the safe design of a tailings retention system are discussed with major emphasis on the geotechnical engineering aspects. The important considerations in developing a meaningful in-service inspection and surveillance program are also covered.

501
Kelly, T.E., R.L. Kink, and M.R. Schipper, Geohydrologic Associates Inc., Albuquerque, NM

Effects of Uranium Mining on Ground Water in Ambrosia Lake Area, New Mexico

Memorandum of the New Mexico Bureau of Mineral Resources 38:313-331; Geology and Mineral Technology of the Grants Uranium Region, Proceedings of a Symposium, Albuquerque, NM, May 13-16, 1979; (pp. 313-331) (1980)

This paper discusses the impact of mining on the principal aquifer in the Ambrosia Lake area, the Westwater Canyon Member of the Morrison Formation. Loss of potentiometric head has resulted in interformational migration of ground water. This migration has produced local deterioration in chemical quality of the ground water. (EIX)

502
U.S. Environmental Protection Agency, Washington, DC

Judicial Review Under EPA-Administered Statutes - Races to the Courthouse

Federal Register 49(108):23152-23155 (1984, June 4)

In 1980 EPA issued a rule fixing a definitely ascertainable time when Clean Water Act rules would be considered issued for purposes of judicial review. This proposal would establish similar rules for other EPA-administered statutes, and is intended to bring greater fairness to "races to the courthouse." Included in the proposal is the Uranium Mill Tailings Radiation Control Act of 1978. 40 CFR is proposed to be amended by adding new Part 23 to include 10 sections, of which 23.8 (Timing of Administrator's action under Uranium Mill Tailings Radiation Control Act of 1978) is as follows: Unless the Administrator otherwise explicitly provides in a particular rule, the time and date of the Administrator's promulgation for purposes of U.S. Code 42:2022(c)(2) shall be at 1:00 P.M. Eastern time (standard or daylight, as appropriate) on the date that is two weeks after the date when notice of promulgation is published in the Federal Register. (JWF)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT ENVIRONMENTAL STUDIES AND SITE SURVEYS

503

Archibold, O.W.

Metal Content of Wind-Blown Dust from Uranium Tailings in Northern Saskatchewan

Water, Air, and Soil Pollution 24(1):63-76 (1985, January)

The moss bag technique of air quality monitoring has been used to assess the spatial distribution of metal particulates as dust from Uranium tailings adjacent to the Lorado Mill in northern Saskatchewan. Monitoring sites were set up at 32 locations on and around the tailings by plasma emission spectroscopy, 8 were found to be deposited on the moss bags at concentrations in excess of 0.01 ug/sq cm/day. Particulate concentrations were generally highest in the central and eastern parts of the tailings dropping off rapidly in the surrounding area. It is probably the sandy texture of the tailings which restricts the distribution of particulates in this region.

504

Bigu, J., M. Grenier, N.K. Dave, T.P. Lim, and J.L. Chakravatti, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Study of Radon Gas Concentration, Surface Radon Flux and Other Radiation Variables from Uranium Mine Tailings Areas

Uranium 1(3):257 (1984, February)

The millings of uranium ore produces large quantities of solid and liquid residues in the form of radioactive tailings. A study of radon gas concentration, surface radon flux, and other radiation variables was conducted at uranium tailings sites in Ontario. Radon gas measurements were conducted at several depths and at the soil/air interface, and showed that radon gas concentrations increase with depth. Radon escaping to the atmosphere is limited to the boundary layer, and the pore concentration of radon in this zone is significantly affected by barometric pressure changes and other meteorological variables.

505

Blackport, R., University of Waterloo, Waterloo Research Institute, Waterloo, Ontario, Canada

Patterns of Groundwater Flow, pH, and Electrical Conductance in the Nordic West Arm Tailings, Elliot Lake, Ontario

OSU-80-00123; 98 pp. (1980, November 25)

The prime objective of the field investigation reported was to install a groundwater monitoring network in and below the west arm Nordic tailings in order to determine the general directions of groundwater flow within the tailings, provide a basis for calculation of the groundwater flux into and out of the tailings, and provide a groundwater sampling network. Areas of upward, downward, and horizontal flow were found. In some areas seepage from the tailings enters the sand aquifer beneath the tailings, and in other areas the seepage enters the permeable bedrock. The chemical composition of pore water in the tailings is variable, in some places highly acidic. The general trends in hydraulic head and gradient were delineated, but it was not possible to define groundwater flow paths within and beneath the tailings, or to carry out mass balance studies.

506

Chandler, B.L., T.A. Shepherd, and D.R. Stewart. Conquista Project, Falls City, TX; Water, Waste and Land, Inc., Fort Collins, CO; Stewart (James H.) and Associates, Inc., Fort Collins, CO

Field Evaporation Test of Uranium Tailings Solution

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 501-504) (1985)

A field experiment was performed to observe the effect on evaporation rate of a uranium tailings impoundment pond water as salt concentration of the water increased. The duration of the experiment was long enough to cause maximum salt concentration of the water to be attained. The solution used in the experiment was tailings pond water from an inactive uranium tailings disposal site in the initial stages of reclamation. The solution was not neutralized. The initial pH was about 1.0 decreasing to a salt gel at the end of the test. The results of the field experiment show a gradual and slight decrease in evaporation efficiency. This resulted as salt concentrations increased and verified the practical effectiveness of evaporation as a water removal method. In addition, the physical and chemical nature of the residual salts suggest that no long-term stability problem would likely result due to their presence in the impoundment during or after reclamation. (Auth)

507

Cherry, J.A., University of Waterloo, Waterloo, Ontario, Canada

Mobility in Groundwater of Contaminants from Uranium Mill Tailings

CONF-8208145; Uranium '82, Proceedings of the 12th Annual Hydrometallurgical Meeting, Toronto, Canada, August 29-September 1, 1982 (1982)

The major regions in North America in which uranium-mill tailings have been and are currently being deposited in surface impoundments are the Elliot Lake district of northern Ontario, northern Saskatchewan, and the uranium districts in the western United States. In each of these regions there are tailings impoundments where tailings-derived contaminants have entered permeable geological deposits beneath the tailings and are migrating in the groundwater zone. Considerable monitoring of zones of contaminated groundwater has taken place at an inactive tailings impoundment in the Elliot Lake district and at four impoundments in Wyoming. The tailings water that has caused groundwater contamination at these sites is acidic, and because of the low pH, the water contains high concentrations of some metals and radionuclides. Geochemical processes cause considerable neutralization of acidic water in the groundwater zone, and the fronts of the acidic groundwater zones move at rates much slower than the groundwater flow rates. Where the pH in the groundwater zone is above 6, solubility constraints and adsorption cause the concentrations of toxic metals and radionuclides to be below drinking water standards but where pH is below 5, high concentrations are common. The rate of movement of the low-pH zones is dependent primarily on the acid-consumption capabilities of the geological deposits. Field studies indicate that the acid-consumption capability of permeable sand deposits at the tailings impoundments is generally very substantial. Investigations of the behavior of tailings-derived contaminants in fractured crystalline or fractured indurated sedimentary rock are needed because many of the tailings impoundments that exist in Canada and in some parts of the United States are situated on these rock types. Little is known regarding the mobility of tailings-derived constituents in groundwater flow regimes in fractured rock.

508

Dave, N.K., N.R. Clcutier, and T.P. Lim, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Elliot Lake Laboratory, Elliot Lake, Ontario, Canada

Radionuclide Levels in Vegetation Growing on Uranium Tailings, Elliot Lake, Ontario

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 263-271) (1985)

In Elliot Lake, Ontario, Canada, most of the inactive uranium tailings have been reclaimed by revegetation where a thick vegetation cover has been established. The surface amendments have also prompted volunteer growth of various species of local trees and shrubs on tailings. Radionuclide levels were measured in various tissues of grasses, legumes and trees growing on uranium tailings at different sites. Leaves, stems, flowers and seeds of creeping red fescue (Festuca rubra L.), red top (Agrostis alba L.) and birds foot trefoil (Lotus corniculatus L.) were found to contain detectable levels of Ra-226 (59 to 396 mBq/g), Pb-210 (equal to or less than 4 to 488 mBq/g and total Pb (less than 1.0 to 7.0 ug/g). On the other hand, other radionuclide levels such as Th-232 (less than 4 mBq/g), Th-230 (equal to or less than 4 to 26 mBq/g), Th-228 (equal to or less than 4 to 7 mBq/g), Ra-224 (equal to or less than 4 mBq/g) as well as total Th (equal to or less than 2 ug/g), total U (equal to or less than 0.2 ug/g) were undetectable. For various species of vegetation growing on different uranium tailings sites, the radionuclide levels ranged as follows: Ra-226 (7 to 1021 mBq/g), Ra-223 (less than 4 to 159 mBq/g), Pb-210 (22 to 255 mBq/g), Th-232 (equal to or less than 4 to 7

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mBq/g), Th-230 (equal to or less than 4 to 22 mBq/g) and Th-228 (equal to or less than 4 mBq/g). At the control sites, all radionuclide levels in the vegetation were below detection limits. In tailings substrate, radionuclide levels were measured as: Ra-226 (326 to 15133 mBq/g), Ra-223 (115 to 5717 mBq/g), Pb-210 (200 to 12961 mBq/g), Th-232 (70 to 570 mBq/g), Th-230 (181 to 1887 mBq/g) and Th-228 (48 to 1406 mBq/g). Lower Th than Ra and Pb levels in tailings substrate were believed to be the cause for the relatively lower Th levels measured in vegetation when compared to Ra and Pb concentrations. No correlation was observed between the level of a given radionuclide in tailings and in the vegetation growing on that tailings. (Auth)

509

Denham, D.H., M.G. Barnes, L.A. Rathbun, and J.A. Young, Pacific Northwest Laboratory, Richland, WA

Monitoring Methods for Determining Compliance with Decommissioning Cleanup Criteria at Uranium Recovery Sites

NUREG/CR-4118; PNL-5361; 28 pp. (1985, June)

Decommissioning of a uranium processing site requires radiological surveys to: (1) identify buildings, equipment, and open land areas that require cleanup, (2) verify that cleanup operations have been successful, and (3) provide a record of the radiological conditions of the site following cleanup. This report describes the instruments, measurements, quality assurance, and statistical procedures that can be used to perform pre- and post-cleanup surveys. The procedures described include: (1) gamma-radiation exposure-rate measurements using micro-R-meters, (2) beta-gamma measurements using Geiger-Mueller tubes, (3) wipe tests for surface contamination, and (4) soil analyses for Ra-226 and other U-238 daughters. During the pre-cleanup survey, locations likely to have Ra-226 concentrations that exceed standards can be identified by gamma-radiation exposure-rate measurements. Samples of soil or other material from locations showing elevated exposure rates then can be analyzed for Ra-226 to determine the boundaries of areas that exceed standards. Measurements of U-238 in the samples can be used to determine whether the Ra-226 is due to mill tailings. Beta-gamma measurements and wipe-analyses at locations that are suspected of being contaminated with uranium can be used to to determine whether uranium concentrations exceed standards for either fixed or removable contamination. A post-cleanup survey that is similar to the pre-cleanup survey can be used to verify that cleanup has been successful. (Auth)

510

Descamps, B., L. Foulquier, Y. Cartier, and Y. Baudin-Jaulent

Contribution of Hydrobiological Measurements to the Radioecological Monitoring of a Uranium Mining and Milling Site in France

IAEA-SM-262/20; STI/PUB-622; CONF-820552; Management of Wastes from Uranium Mining and Milling, Proceedings of an IAEA and OECD/NEA International Symposium, Albuquerque, NM, May 10-14, 1982. International Atomic Energy Agency, Vienna, 745 pp.; (pp. 523-533) (1982, May 10-14)

The first results are given of a hydrobiological study, carried out under a CEA/EEC contract, of the Lodeve uranium mining and milling site in southern France. Water, sediment, plant and fish samples were taken in May 1981 and in 1982. At a distance of some three kilometers downstream from the mine, there was an increase in the radium and uranium content of all samples. The uranium and radium in the water are found mainly in a dissolved state, and the uranium content is much higher. In the case of the sediment, however, the radium content is higher, which seems to indicate radium's strong preference for "fixing" itself to sediments. Fine particle size encourages the fixation of the two radionuclides. In the case of semi-aquatic plants, the increases observed are larger for uranium than for radium and are greater in the parts below ground than in those above it. Specific laboratory experiments are planned for the purpose of determining, among other things, the effect of the chemistry of the host environment on the fate of the radium and uranium and the proportions transported by the two pathways (from water and sediment) to the plant. (Auth)

511

Dreesen, D.R., and E.J. Cokal, Los Alamos National Laboratory, Los Alamos, NM

Plant Uptake Assay To Determine Bioavailability of Inorganic Contaminants

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Water, Air, and Soil Pollution 22(1):85-93 (1984, January)

A laboratory technique has been developed to rapidly assess the potential uptake of contaminants by plants growing into waste burial sites. A soil-less planting media was used to provide rapid plant growth and reproducible growing conditions. The uptake of contaminants by several plant species grown on uranium mill tailings materials has been examined. The bioavailability of Mo, Se, Cl, and other trace metals in tailings was greater than in a surface soil from a uranium mining area. Significant differences in nutrient and contaminant contents in aboveground biomass were found between species.

512
Eaton, R.S., Atomic Energy Control Board, Ottawa, Ontario, Canada

Radon and Radon Daughters in Public, Private and Commercial Buildings in Communities Associated with Uranium Mining and Processing in Canada

CONF-810153; Natural Radiation Environment, K.G. Vohra, et al. (eds.), Proceedings of the Second Special Symposium, Bombay, India, January 19-23, 1981; (pp. 489-496) (1982)

The elevated indoor radon levels in certain communities in Canada have been studied. An overview of the investigational and remedial action programs are presented in this paper. It is suggested that radon daughter concentrations can be controlled by: (a) removing source; (b) placing a barrier between the source and the living space; (c) diverting the radon before it enters a building; and (d) increasing the ventilation rate. All methods have been proven, but no one technique is the most cost effective because of widely varying conditions found in older housing.

513
Fayer, M.J., and W. Conbere, Pacific Northwest Laboratory, Richland, WA

The Analysis of Drainage and Consolidation at Typical Uranium Mill Tailings Sites

NUREG/CR-4192; PNL-5421; 49 pp. (1985, May)

The computer code TRUNC was used to analyze three aspects of uranium mill tailings dewatering: the coupling of consolidation and fluid flow, drainage design, and cover load. One-dimensional simulations of the effects of consolidation on fluid flow within a tailings pile of either slimes or a sand/slimes mix showed that drainage flux was greater for a consolidated system early in the simulation. However, after days 1,400 and 160 of the simulations for the slimes and sand/slimes mix, respectively, the fluxes from the non-consolidating systems were greater. In the sand/slimes mix, the non-consolidating system had a cumulative flux of only 34% of that of the consolidating system. This difference indicates that consolidation and fluid flow should not be coupled for the slimes. Two-dimensional simulations of an actual tailings pile drainage design showed that a sand blanket drain increased the rate of drainage and settlement. The sand blanket drain also significantly reduced differential settlement across the pile. This indicates that the use of a sand blanket drain could enable earlier placement of the cover system after tailings emplacement. In simulations of covered and uncovered tailings piles, nearly the same quantity of water was removed from each; hence, surface settlement was slower when the tailings pile was not covered. (Auth)

514
Fayer, M.J., and T.J. McKeon, Pacific Northwest Laboratory, Richland, WA

Settlement of Uranium Mill Tailings Piles: A Comparison of Analysis Techniques

NUREG/CR-3972; 93 pp. (1984, December)

Uranium mill tailings piles pose a number of environmental problems including the emission of radon gas to the atmosphere and the seepage of chemical contaminants to the ground water. These hazards have prompted government agencies to seek to have the piles covered and drained. In the process of covering and draining the piles, the piles may settle and cause the cover to crack, rendering it less effective as a radon gas barrier. To avoid this problem a method is needed to predict the amount of total settlement and the time of settlement so that the covers can be placed at the optimum time. Several methods for analyzing the settlement of the tailings piles exist today. Terzaghi's theory and the two-stress-state approach, both empirical, can be used to predict saturated and partially saturated total settlement, respectively, when pore water pressures are decreased or a cover is added. A third method for analyzing settlement is the computer code TRUNC (TRansient UNsaturated Consolidation), developed by Pacific Northwest Laboratory with the support of the U.S. Nuclear Regulatory Commission. TRUNC is a modified version of the computer code TRUST, which was written for variably saturated flow in deformable porous media. The two empirical methods of settlement analysis were compared to the computer code TRUNC. The three methods were used to predict settlement of a 12.2-m-deep pile of tailings slimes with a drain at the bottom. The simpler, empirical methods of settlement analysis were just as effective as TRUNC in predicting total settlement. For saturated tailings, predictions of total settlement by Terzaghi's theory and TRUNC were in close agreement (1.69 and 1.72 m, respectively). For partially saturated tailings, the simplified stress-state approach and TRUNC predicted similar total settlements (0.52 and 0.51 m, respectively). Terzaghi's theory, as applied, overestimated the time of settlement under saturated conditions (170 days versus 140 days predicted by TRUNC) because it did not account for gravitational gradients. No empirical or analytical means were available to predict the time of settlement under partially saturated conditions. The TRUNC code, however predicted 1500 days (4.1 years) for settlement under partially saturated conditions. If the magnitude of partially saturated settlement is considered significant, then the time over which it occurs will most likely be the deciding factor in determining when to place the cover on the tailings pile. (Auth)(JWF)

515

Finley, J.B., M.D. Harvey, and C.C. Watson, Colorado State University, Department of Earth Resources, Fort Collins, CO; Water Engineering and Technology, Inc., Fort Collins, CO

Experimental Study: Erosion of Overburden Cap Material Protected by Rock Mulch

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 273-282) (1985)

An experimental study of the efficacy of rock mulch in protecting the integrity of the overburden cap of a simulated uranium mill tailings pile was based on results from studies of talus deposits. These are naturally occurring analogs in which a higher permeability coarse-grained layer overlies a lower permeability fine-grained layer. The experimental results showed that under very conservative experimental conditions erosion of the cap materials occurred. A self-armoring process in which the gravels at the interface between the mulch and cap materials, became embedded, to a depth that was equivalent to their median diameter, had significant effects on runoff, sediment yield, gross erosion and sediment delivery ratio. These variables were minimized by the smallest gravel size (12.7 mm) which had the greatest surface area to volume ratio. (Auth)

516

Flannagan, J.C., W.H. Morton, and T.A. Ward

Ground Water Management Around Uranium Mine Waste Areas, Mary Kathleen, Australia

CONF-8312100; Ground Water and Man, Volume 2 - Ground Water and the Environment, Proceedings of an International Conference, Sydney, Australia, December 5, 1983; (pp. 81-88) (1983)

Investigations of groundwater resources in the vicinity of the Mary Kathleen Uranium Mine were carried out with the intention of providing an alternative water source for the milling operations. The milling process included acid leaching of the ore and disposal of tailings and acidic effluent. A preliminary hydrogeological review indicated that an area 2.5 km downstream from the mine and mill offered a good potential for groundwater development. This area included the catchment area containing the mill tailings disposal dam and effluent evaporation ponds. Field investigations identified a groundwater basin totally contained by impermeable basement rock within the area. Production wells were installed at the overflow outlet to the basin, which not only provided an alternative source of water for the mill but also gave a controlling device for monitoring and retrieval of any seepage which occurred from the tailings and effluent pond areas. An analysis of the catchment area soils for infiltration rates and geochemistry for the purpose of evaluating catchment yields and baseline groundwater quality data revealed a natural capacity in the deep weathering profile to neutralize acidic effluent and to adsorb heavy metals and radionuclides in solution. These geochemical attributes plus the contained nature of the groundwater made it an ideal location for effluent disposal. The ability of soils to neutralize and demineralize acidic effluent gave advantages to the Mary Kathleen Mine not realized in other uranium mines where effluent is neutralized prior to disposal.

517

Gan, T.H., G.C. Mason, and K.N. Wise

Survey of Radon Emanation Rates at Port Pirie Tailings Dams

ARL/TR-060; Annual Review of Research Projects for 1982; (pp. 22-24) (1983, September)

A survey was carried out to determine radon emanation rates from tailings at a plant used for extraction of uranium from concentrates between 1955 and 1961 and for extraction of rare earth elements from monazite sands between 1969 and 1972. The total emanation rate for all dams at the plant was determined to be 460 plus or minus 90 kBq/s. There was an enhanced radon flux following rain. Typical values lay between 0.7 and 1 Bq/sq m/s under dry conditions and rose to about 9 Bq/sq m/s a few hours after rain.

518

Gonzales, P.A., and B.J. Adams, University of Toronto, Department of Civil Engineering, Ontario, Canada

Mine Tailings Disposal: 2 - Hydrologic Evaluation of Disposal Sites

UTCE-80-06; 40 pp. (1980, June)

The hydrologic evaluation of mine tailings disposal sites after they are abandoned is considered in relation to their potential environmental impact on a long-term basis. There is a direct relation between the amounts and types of water leaving a disposal site and the severity of the potential damage to the environment. The evaluation of the relative distribution of the precipitation reaching the ground into evaporation, runoff, and infiltration is obtained for a selected site and type of tailings material whose characteristics and physical properties were determined in the soils laboratory. A conceptual model of the hydrologic processes involved and the corresponding mathematical model were developed to simulate the physical system. A computer program was written to solve the set of equations forming the mathematical model, considering the physical properties of the tailings and the rainfall data selected. The results indicate that the relative distribution of the precipitation depends on the surface and upper layer of the tailings and that the position of the groundwater table is governed by the flow through the bottom of the profile considered. The slope of the surface of the mass of tailings was found to be one of the principal factors affecting the relative distribution of precipitation and, therefore, the potential pollution of the environment.

519

Gupta, D.C., M.S. Nataraja, and M. Blackford, U.S. Nuclear Regulatory Commission, Washington, DC

Seismic Design Considerations for Uranium Mill Tailings Disposal Facilities

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 23-32) (1985)

Control of release to the environment of radioactive wastes is essential during the operating life of the disposal facilities and for centuries after the disposal operation has ceased. The need for increased attention is being felt on the possible effects of seismic loading on long-term performance of disposal facilities and retention systems for uranium mill tailings. The importance, extent, and method of seismic design needed for an evaluation of the facility generally depend on the seismicity of the region where the waste disposal facility is located and the associated hazard. For regions where the hazard is high or the seismic conditions are severe, extensive investigations and analyses may be required. Investigations and analyses of a lesser detail may be sufficient in many cases if consequences of seismically induced failure are small and can be safely mitigated. Various factors to be investigated in the selection of a design earthquake for seismic analysis include regional tectonic setting, seismic history of the area, seismo-tectonic structures, local or site geology, and seismic attenuation and amplification. After defining the characteristics of the expected seismic ground motion at a waste facility site, seismic analysis of the facility may be performed and adequacy of the facility to withstand postulated earthquake loading

evaluated using generally accepted procedures. Adequate consideration of seismically induced settlement and flow or liquefaction potential would generally be an important aspect of such an evaluation. (Auth)(DCM)

terms for tailings piles or a uranium mill complex. These are: quantity of tailings, fluid cover, saturation of tailings, non-uniformity of tailings storage, and external short-term factors. (Auth)

520

Hans, J.M., Jr., U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV

Techniques for the Estimation of Radon-222 Source Terms for Uranium Mill Tailings Piles

CONF-770581; Methods for Measuring Radiation in and Around Uranium Mills, Proceedings of a Workshop, Albuquerque, NM, May 23-26, 1977. Atomic Industrial Forum, Inc., Washington, DC, 434 pp.; (pp. 181-195) (1977, May 23-26)

Uranium mill tailings piles are most generally very large, irregularly shaped mill waste storage areas covering a few to several hundreds of acres. They contain, for the most part, practically all of the radionuclides previously produced by the radioactive decay of uranium. One radioisotope of the uranium decay chain, radon-222, is of particular importance in that it is a noble gas and can readily diffuse from the tailings and be carried by wind currents into the surrounding environment. Radon-222 has a radioactive half-life of 3.8 days resulting in the production of several short-lived radioactive principle daughters which become attached to airborne dust particles. The inhalation of radon and its short-lived daughters can result in a radiation dose to the respiratory tract, however, the largest percentage of the dose will result from the short lived daughters. These radionuclides are thought to be the largest contributors to human exposure from the tailings piles. Basically, two techniques can be used to evaluate environmental exposures from the radon and progeny for compliance purposes or to estimate health effects. These are accomplished by sampling ambient radon or progeny at discrete locations around the uranium mill sites and tailings piles, or by dispersion equations to estimate environmental exposures. Ideally, sampling should be conducted for a period of one year to account for seasonal meteorological variations using the former technique and local meteorological parameters should be collected for a year for the latter technique. Several methods are presented that may be useful for determining radon source

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Harms, V.L., Saskatchewan Department of the Environment, Regina, Canada

Plant Taxonomic Survey of the Uranium City Region, Lake Athabasca North Shore, Emphasizing the Naturally Colonizing Plants on Uranium Mine and Mill Wastes and Other Human-Disturbed Sites

TWPFH-82-1; 141 pp. (1982, July)

A goal of this study was to acquire more complete baseline data on the existing flora of the Uranium City region, both in natural and human-disturbed sites. Emphasis was given to determining which plant species were naturally revegetating various abandoned uranium mine and mill waste disposal areas, other human-disturbed sites, and ecologically analogous sites. Another goal was to document the occurrence and distribution in the study region of rare and possibly endangered species. A further objective was to suggest regionally occurring species with potential value for revegetating uranium mine and mill waste sites. Field investigations were carried out in the Uranium City region during August, 1981. During this time, 1412 plant collections were made; 366 plant species including, trees, shrubs, forbs, graminoids, lichens, and bryophytes, were recorded. The report includes an annotated checklist of plant species of the Uranium City region and a reference index of plant taxa indicating species that have high revegetation potential.

522

Hartley, J.N., J.A. Glissmeyer, and O.F. Hill, Pacific Northwest Laboratory, Richland, WA

Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations

NUREG/CR-4088; PNL-5338; 65 pp. (1985, June)

Pacific Northwest Laboratory, under contract to the U.S. Nuclear Regulatory Commission (NRC), identified and evaluated methods for estimating radioactive and toxic particulate and gaseous airborne releases from uranium milling operations. Such methods need to be standardized so that all uranium mills can provide adequate data for NRC evaluation of potential environmental impacts and of compliance with 10 CFR 20, 40 CFR 190, and the National Environmental Policy Act. The general method for calculating source terms is to multiply together a normalized emission rate, contaminant content, emission control factor, and processing rate for each process being evaluated. This report describes the sources of airborne releases (ore storage area, ore crushing and grinding, ore processing, yellowcake production, and tailings impoundment) and the calculational procedures for estimating radioactive and toxic terms. Example calculations are provided. (Auth)

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Hinton, T.G., and F.W. Whicker, Pathfinder Mines Corporation, Shirley Basin, WY; Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO

A Field Experiment on Rn Flux from Reclaimed Uranium Mill Tailings

Health Physics 48(4):421-427 (1985, April)

Design and construction techniques are described for a 1.6 ha experimental reclamation plot consisting of a 1 m thick slab of uranium mill tailings covered with various depths of overburden. A passive, activated charcoal device was developed and used for measurements of Rn flux at the soil surface. Observations on Rn flux versus overburden depth indicated that tailings covered with 1.5 m of revegetated or 0.3 m of bare overburden had Rn exhalation rates comparable to background. Vegetated subplots exhibited a significantly higher (often an order of magnitude) flux than the bare subplots. A positive correlation was observed between precipitation quantities and Rn flux. (Auth)

524

Hundemann, A.S., National Technical Information Service, Springfield, VA

Uranium Mining and Milling Environmental Studies: Citations from the NTIS Data Base

PB-80-805443; 208 pp. (1980)

Pollution, public and occupational health, and waste management associated with uranium ore recovery and processing are cited. The monitoring and control of contamination in air and effluents in the mining vicinities are discussed in this collection of federally-funded research. This updated bibliography contains 242 abstracts, 39 of which are new entries to the previous edition. (Auth)(JWF)

525

Kalin, M., Saskatchewan Department of the Environment, Regina, Canada

Environmental Conditions of Two Abandoned Uranium Mill Tailings Sites in Northern Saskatchewan

INIS-mf-8924; 103 pp. (1984)

Two abandoned uranium mill tailings sites near Uranium City, Saskatchewan, have been studied in an attempt to follow the natural rehabilitation processes. The Gunnar site is a largely terrestrial environment while the Lorado mill tailings were discharged mainly into Nero Lake. This report describes the ecological conditions of both sites, potential long-term environmental degradation, and possible measures to assist the recovery of both areas.

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Kalkwarf, D.R., H.D. Freeman, and J.N. Hartley, Pacific Northwest Laboratory, Richland, WA

Validation of Methods for Evaluating Radon-Flux Attenuation Through Earthen Covers

NUREG/CR-3457; PNL-5092; 37 pp. (1984, August)

Field and laboratory measurements were made to test the validity of methods for calculating radon-flux attenuation through earthen covers as described in "A Handbook for the Determination of Radon Attenuation Through Cover Materials," NUREG/CR-3533. The validity of the diffusion equations presented in the handbook was established by the generally good agreement between the measured radon flux at six field sites and the flux predicted when measured properties of soil underlying these sites were used in these equations. When approximate values presented in the handbook for various soil properties were used in the diffusion equations, the predicted fluxes were larger than the measured values by factors of up to 31. However, investigation of the theoretical relationship between the radon flux from an earth-covered tailings pile and the thickness of that cover indicated that the latter would only be overestimated by a factor of up to 1.5 at field sites similar to those examined in this study. (Auth)

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Landa, E.R., and L.R. Stieff, U.S. Geological Survey, Reston, VA; Robertson Research, Inc., Houston, TX

Radium-226 Contents and Radon-222 Emanation Coefficients of Particle Size Fractions of Uranium Mill Tailings

Health Physics 47(1):140; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

Uranium mill tailings samples derived from acid-circuit, alkaline-circuit, and mixed-circuit processing were separated into particle size fractions ranging from +10 mesh (greater than 2 mm) to -325 mesh (less than 44 u), by both dry and wet separation techniques. The radium-226 content and radon-222 emanation coefficients of these fractions were determined. Dry tailings show a high degree of aggregation which tends to mask the relationship of properties such as radium content and radon emanating power to dispersed particle size. Coarse tailings fractions (+325 mesh) had emanation coefficients which were from 25 to 45 percent lower than those of their fine fraction counterparts. Radionuclide-host mineral associations identified in tailings fractions by nuclear emulsion microscopy are discussed. Emanation coefficients measured for tailings derived from a salt roast/carbonate leach process suggest that such ore roasting does not lead to reductions in radon emanation in the tailings derived therefrom. (Auth)

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Larson, M.B., and D.B. Stephens, New Mexico Institute of Mining and Technology, Socorro, NM

A Comparison of Methods To Characterize Unsaturated Hydraulic Properties of Mill Tailings

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 335-346) (1985)

The characterization of mill tailings is a vital first step to quantify fluid movement within tailings for purposes of seepage control, stabilization, and reclamation. To evaluate hydraulic properties of partially saturated sediments, there exists a variety of procedures developed primarily by soil physicists. It is not uncommon for most characterization work to be done on disturbed samples rather than on undisturbed samples or in-situ testing. The purpose of this paper is to discuss the results of extensive analyses on copper mill tailings sands to characterize saturated and unsaturated hydraulic conductivity and water content-pressure head relationships. These tailings characteristics were determined using various empirical methods, theoretical models, laboratory techniques and field procedures. In most cases, repacked samples tended to have unsaturated hydraulic characteristics similar to a slightly finer textured material. Unsaturated hydraulic conductivity predictions showed considerable variability, as did the results of some procedures to determine water content-pressure head relationships. Empirical or theoretical methods, which require only a few easily determined index parameters, may provide reasonably good estimates of some hydraulic properties at a substantial reduction in cost and effort. (Auth)

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Lawrence Berkeley Laboratory, Berkeley, CA

Geochemistry

LBL-15500; Lawrence Berkeley Laboratory Earth Sciences Division Annual Report; (pp. 65-126) (1983, September)

The geochemical research summaries focus upon the behavior of subsurface aqueous fluids at high temperatures and pressures. Concern about radioactive waste disposal has led to extensive modeling of the repository environment and to the analysis of ion migration and the chemical interaction of fluids flowing through rocks. Nat-

ural analogs of a radionuclide repository are reported, as well as the movement of meteoric water through old mill tailings dumps containing uranium. Such studies also involve maintaining a data base on aqueous radionuclide species and on the surface chemistry of minerals likely to be used in repository barriers. Investigations of the properties of silicate liquids are discussed. This effort includes making calorimetric measurements on solid silicate compounds and their corresponding liquids to contribute to the fundamental thermodynamic data of geologic materials.

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Lewis, G.J., and D.B. Stephens, New Mexico Institute of Mining and Technology, Socorro, NM

Analysis of Infiltration Through Mill Tailings Using a Bromide Tracer

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 347-359) (1985)

Infiltration of precipitation into tailings impoundments as a means of recharge to underlying materials is often considered insignificant, particularly in arid and semiarid environments. A series of experiments was performed to investigate the behavior of infiltrated precipitation into tailings soils, by the use of a bromide tracer. A bromide tracer was applied to the surface of columns driven into the tailings to monitor downward advancement of tracer-laden water. Controlled laboratory experiments on the behavior of the bromide tracer under varying precipitation events and initial soil moisture contents were also conducted. Results indicate that a definite downward migration of infiltrated precipitation occurs, particularly with large magnitude precipitation events, and that, eventually, some fraction of the infiltrated precipitation may continue downward below the zone affected by evaporation. The use of an artificially applied bromide tracer to monitor depth of infiltration of precipitation is a simple, safe technique that can provide valuable information for long-term tailings management strategies at low cost. (Auth)

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McLin, S.G., and P.L. Tien, University of Oklahoma, Norman, OK

Hydrogeologic Characterization of Seepage from a Uranium Mill Tailings Impoundment in New Mexico

EPA/ET AI; Aquifer Restoration and Ground Water Monitoring, Proceedings of the Second Symposium, Columbus, OH, May 26-28, 1982; (pp. 343-358) (1982)

The seepage of waste liquids from a uranium mill tailings impoundment in New Mexico into shallow outcroppings of an interbedded sandstone-shale sequence of the upper Gallup sandstone aquifer is described. The potential for extensive off-site subsurface contaminant migration is characterized. Surface and photogeologic mapping efforts depict the presence of major regional subsurface fracture trace adjacent to the disposal site. Surface electrical resistivity, borehole geophysical, and co-refractographic analyses are used to detect extensive contaminant movement. A system of pumping wells was installed to prevent further plume movement. Monitoring efforts are continuing to assess the feasibility of total containment on a long-term basis.

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Morin, K.A., University of Waterloo, Waterloo, Ontario, Canada

Prediction of Subsurface Contaminant Transport in Acidic Seepage from Uranium Tailings Impoundments

Dissertation Abstracts International, Section B 45(5):1403 (1984, November)

A conceptual model for the prediction of aqueous contaminant transport in acidic subsurface seepage from uranium-tailings impoundments is developed based on evaluation of field data obtained during detailed monitoring of a sand aquifer at an inactive tailings area near Elliot Lake, Ontario, and based on published data from other sites. Tailings seepage problems typically occur in unconfined, horizontal, sand aquifers with impermeable bases. The conceptual model divides the aquifers into three sections: the "inner core" adjacent to the tailings, the "neutralization zone", and the "outer zone". The inner core contains tailings water with low pH and high concentrations of iron, aluminum, and sulfate, which has passed unaltered into the aquifer. The outer zone, which is downgradient of the inner core, contains neutral-pH,

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relatively low-iron, low-aluminum, and low-sulfate water. The neutralization zone is the transition region between the inner core and the outer zone. As inner-core water flows downgradient, it enters the neutralization zone where calcite is present, and pH and acidity are neutralized. Upon neutralization, aluminum precipitates generally as Al(CH)3 and iron precipitates as FeCO3 (siderite) and/or Fe(OH)3. As a result of calcite dissolution into the high-sulfate solution, gypsum precipitates. Thus, concentrations of major ions decrease and the migration of the inner core is retarded with respect to groundwater velocity. The aqueous behavior of radionuclides and the controls on radionuclide concentrations are evaluated by available information and by the chemical-equilibrium computer program, WATRAD, which was developed as part of this thesis. In order to simulate the conceptual model, a computer program, ADNUET, is developed and is applied to case studies in order to simulate the development of present conditions and to predict future migration of the inner core and the neutralization zone with the resulting water chemistry. Emphasis during model development was placed on minimizing execution costs. ADNUET also shows that the neutralization zone is composed of several sub-regions; the pH and chemistry of each sub-region is dominated by one of the compounds of the conceptual model. Each sub-region has a unique retardation factor.

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Murray, D.R., Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Elliot Lake Laboratory, Elliot Lake, Ontario, Canada

Influence of Uranium Mill Tailings on Tree Growth at Elliot Lake

CIM Bulletin 71(800):79-81 (1978, December)

A four-year study was carried out to determine the ability of coniferous trees to aid in the reclamation of uranium tailings at Elliot Lake. Five species were planted: white cedar, white spruce, jack pine, scotch pine, and red pine. More than 570 bare-root, two-year old seedlings were planted on bare tailings and in areas of established grasses. A further division was made between areas of coarse and fine tailings. Over-all survival and growth of the trees has been far below expectations based on previous experience with several varieties of grasses. The criteria for assessment have been per cent survival and yearly growth as determined by plant height. Pine was superior, with 68% survival when planted in bare coarse tailings, 45% for vegetated coarse tailings, and 34% for vegetated fine tailings. Cedar had the worst survival rates at 49%, 14%, and 7% respectively. No species survived on bare fine tailings. The survival and growth of the coniferous trees have been related to species, environmental conditions, and tailings properties. (Auth)

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Murray, D.R.

Soil Profile Development in Vegetated Uranium Tailings

CIM Bulletin 77(863):106-107 (1984)

A promising long-term solution to uranium tailings reclamation has been the establishment of vegetation directly on the waste material. The soil profiles of areas vegetated for 0, 3, 8, and 10 years are characterized as to the extent of soil development. The characteristics are compared with the visually interpreted soil profile. Organic matter content is presently the best analytical judge of soil development. Vegetation procedures have produced a build-up of organic matter in the top 10 cm of tailings where natural microbial populations flourish. The C:N ratio is high and the profile depth shallow, suggesting the need for additional fertilizer applications. (Auth)

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Murray, D.R., and M. Turcotte, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Tree Growth Studies on Uranium Mill Tailings

MRP/MRL-82-19; 28 pp. (1982, January)

Coniferous trees planted in 1974 and deciduous species that have volunteered since 1970 on uranium mill tailings that had been stabilized to varying degrees using limestone and vegetation were evaluated. Their survival and growth rates were compared with those from other investigations. Competition for light appears to be a major contributor to mortality. Differences in soil moisture conditions under a tree stand as compared to those under a grass sward are potentially significant enough to affect

the tailings hydrology and effluent contamination. Recommendations include planting seeds of deciduous species or deciduous and coniferous seedlings on strips of freshly disturbed tailings. The disturbed strips would provide reduced competition for the initial year and assist in tree survival. The planting of block stands of coniferous or deciduous trees would be useful for evaluating the hydrological impact of the trees as compared to the grasses.

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Nelson, R.W., T.J. McKeon, and W. Conbere, Pacific Northwest Laboratory, Richland, WA

Leachate Plume Migration Downgradient from Uranium Tailings Disposal in Mine Stopes

NUREG/CR-4061; PNL-5318; 80 pp. (1985, February)

A method previously developed at Pacific Northwest Laboratory has been simplified and extended to better evaluate the environmental consequences of below-water-table disposal of uranium mill tailings in mine stopes. The method described uses analytical expressions for the velocity potential and examines numerically the convective transport of tailings liquor and leachate through the aquifer and into a water supply well located downgradient from the mine stope. The overall dependence of the leachate plume size and shape on the hydrologic parameters and the tailings disposal geometry are presented in graphical form for use in preliminary assessments. The graphical results are also used to set up worst-case scenarios for return of the leachate constituents to the biosphere via the pumped water supply well. The interactive computer models developed to evaluate such worst-case conditions are presented, discussed, and used to evaluate four typical situations.

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Nielson, K.K., V.C. Rogers, and G.W. Gee, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Diffusion of Radon Through Soils: A Pore Distribution Model

Soil Society of America Journal 48(3):482-487 (1984)

A mathematical model was developed for calculating radon diffusion coefficients from water contents and pore size distributions of soil materials. The model accounts for radon diffusion in the air-filled and water-filled pore space, for radon solubility in water, and for Knudsen diffusion in extremely small air-filled spaces. The model considers soil pores to be composed of all possible serial combinations of the size increments from a measured pore size distribution. Diffusion coefficients for the resulting composite pores are computed and then used to calculate the overall diffusion coefficient of the soil by assuming parallel diffusion through all of the pore combinations. The resulting diffusion coefficients increase with the median pore diameter, and decrease with increasing soil water contents and with increasing widths of the soil pore size distribution. The model diffusion coefficients compare well with measured coefficients and with empirical calculations and are useful in evaluating the required soil cover thickness for uranium mill tailings reclamation. (Auth)

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Olson, T.M., and B.G. Lewis, Weston (Roy F.), Inc., Northbrook, IL

Selenite Ion Adsorption on Clays and Other Mechanisms for Selenium Removal from Uranium Mill Tailings

Transactions of the American Institute of Mining, Metallurgical and Petroleum Engineers 274:2040-2045 (1983)

H2SeO3 and HSeO3(-) are removed from uranium mill tailings pond seepage by soil or clay pond liners if illite, kaolinitic, or bentonite clays or iron oxides are present. The adsorption of H2SeO3 and HSeO3(-) on clays varied by several orders of magnitude and decreased in the order of illite greater than kaolinite greater than bentonite. Maximum adsorption of H2SeO3 and HSeO3(-) occurred between pH 2.5 and the zero charge point of the clay. Virtually all H2SeO3 and HSeO3(-) was removed from the tailings at pH 7 by adsorption on precipitated metal hydroxides.

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Opitz, B.E., M.E. Dodson, and R.J. Serne, Pacific Northwest Laboratory, Richland, WA

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Uranium Mill Tailings Neutralization: Contaminant Complexation and Tailings Leaching Studies

NUREG/CR-3906; PNL-5179; 71 pp. (1985, May)

Laboratory experiments were performed to compare the effectiveness of limestone ($CaCO3$) and hydrated lime [$Ca(OH)2$] for improving waste water quality through neutralization of acidic uranium mill tailings liquor. The experiments were designed to also assess the effects of three proposed mechanisms, carbonate complexation, elevated pH, and colloidal particle adsorption, on the solubility of toxic contaminants found in a typical uranium mill waste solution. Of special interest were the effects each of these possible mechanisms had on the solution concentrations of trace metals such as Cd, Co, Mo, Zn, and U after neutralization. Results indicated that the neutralization of acidic tailings to a pH of 7.3 using hydrated lime provided the highest overall waste water quality. Both the presence of a carbonate source or elevating solution pH beyond pH of 7.3 resulted in a lowering of previously achieved water quality, while adsorption of contaminants onto colloidal particles was not found to affect the solution concentration of any constituent investigated. At solution pH greater than 6.3, carbonate complexation affects the solid phase control for uranium and perhaps zinc concentrations, while molybdenum concentrations were found to be a function of elevated solution pH. Arsenic, Cd, Cr, Pb, and V were effectively removed from solution at all pH values exceeding 6.5, regardless of solution carbonate content. Cobalt removal is best at pH values above 7.3, and copper removal may be enhanced in carbonate- bearing solutions. Selenium removal is only 50% for either reagent at all pH values studied. Uranium solution concentrations in the presence of excess carbonate reagents were significantly higher than in solutions created by hydrated lime-only neutralization. but all solutions were below U.S. Nuclear Regulatory Commission radiation protection limits. Molybdenum was effectively removed from solution at a pH of 6.3 but was present at a pH of 9.0 in concentrations corresponding to those found in the unneutralized tailings liquor. Aqueous speciation calculations with the computer code MINTEQ were used to clarify these observed results. (Auth)

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Osiensky, J.L., University of Idaho, Moscow, ID

A System for the Hydrogeologic Analysis of Uranium Mill Waste Disposal Sites

Dissertation Abstracts International, Section B 45(6):1713; PhD Thesis; 445 pp. (1983)

Most of the uranium mill wastes generated before 1977 are stored in unlined tailings ponds. Seepage from some of these ponds has been of sufficient severity that the U.S. Nuclear Regulatory Commission (NRC) has required the installation of withdrawal wells to remove the contaminated groundwater. Uranium mill waste disposal facilities typically are located in complex hydrogeologic environments. This research was initiated in 1980 to analyze hydrogeologic data collected at seven disposal sites in the U.S. That have experienced problems with groundwater contamination. The characteristics of seepage migration are site specific and are controlled by the hydrogeologic environment in the vicinity of each tailings pond. Careful monitoring of most seepage plumes was not initiated until approximately 1977. These efforts were accelerated as a consequence of the Uranium Mill Tailings Act of 1979. Some of the data collected at uranium mill waste disposal sites in the past are incomplete and some were collected by methods that are outdated. Data frequently were collected in sequences which disrupted the continuity of the hydrogeologic analysis and decreased the effectiveness of the data collection programs. Evaluation of data collection programs for seven uranium mill waste disposal sites in the U.S. has led to the development and presentation herein of a system for the hydrogeologic analysis of disposal sites.

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Pai, H.L., P. Taylor, E.G. Baker, and J.H. Aitken, University of Toronto, Department of Chemical Engineering and Applied Chemistry, Toronto, Ontario, Canada; Canada Ministry of Labour, Radiation Protection Service, Toronto, Ontario, Canada

The Atmospheric Transportation of Uranium Dust from Tailing Areas in the Elliot Lake Region

Health Physics 47(1):147-148; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

A time-averaging radon Working Level environmental monitor reported to the 1982 Health Physics Annual

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Meeting has been used to measure simultaneously the time-average concentration of uranium dust in air by neutron activation analysis of the filter paper. Fission products, primarily from thermal neutron fission of U-235, are detected using 10 microns polycarbonate film, instead of detecting the betas emitted by U-239 after neutron capture by U-238. The advantage of detecting fission products is that there is no limit imposed on neutron irradiation time by saturation of the 23 minute activity of U-239. The longer the time of irradiation, the higher will be the track density. This makes it feasible to use a low flux neutron source in the laboratory rather than a higher flux reactor. The neutron irradiation facility is a 500 ug Cf-252 source with a total output of 10(E+9) neutrons per second. The irradiation facility is equipped with a remote control device which automatically brings the sample to a fixed irradiation position. A sensitivity of less than 10(E-12) g of natural uranium/liter of air is achieved for uranium dust collected on a filter paper (1.5 cm outside diameter) using a pump with a flowrate of 30 l/hr, operating continuously for 30 hours and then irradiated for 7 days. Two years results (monthly average) around tailing areas near Elliot Lake, Ontario will be presented and compared with the annual variation of the WL value at the sites. (Auth)

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Peterson, S.R., R.J. Serne, A.R. Felmy, R.L. Erikson, K.M. Krupka, and G.W. Gee, Pacific Northwest Laboratory, Richland, WA

Interactions of Acidic Solutions with Sediments: A Case Study

NUREG/CP-0052; CONF-8308126; Nuclear Waste Management Research on Geochemistry of High Level Waste Disposal, Proceedings of the Nuclear Regulatory Commission Research Annual Review Meeting, Reston, VA, August 30-September 1, 1983; (pp. 513-535) (1984, May)

A methodology is presented for investigating the chemical interactions of acidic solutions with sediments. The MINTEQ geochemical computer code was used to predict solid-phase reactions that might occur when acidic solutions contact neutral sediments which, in turn, may control the concentrations of certain dissolved components. Results of X-ray diffraction analysis of laboratory samples of sediments that have been contacted with acidic uranium mill tailings solutions suggest gypsum and jarosite precipitated. These same mineralogical changes were identified in sediment samples collected from a drained uranium mill evaporation pond (Lucky Mc mine in Wyoming) with a 10-year history of acid attack. Geochemical modeling predicted that these same phases and several amorphous solids not identifiable by X-ray diffraction should have precipitated in the contacted sediments. An equilibrium conceptual model consisting of an assemblage of minerals and amorphous solid phases was then developed to represent a sediment column through which uranium mill tailings solutions were percolated. The MINTEQ code was used to predict effluent solution concentrations resulting from the reactions of the tailings solution with the assemblage of solid phases in the conceptual model. The conceptual model successfully predicted the concentrations of several of the macro-constituents (e.g. Ca, SO4, Al, Fe, and Mn), but was not successful in modeling the concentrations of trace elements. The lack of success in predicting the observed trace metal concentrations suggests that other mechanisms, such as adsorption, must be included in future models. The geochemical modeling methodology coupled with the laboratory and field studies should be applicable to a variety of waste disposal problems.

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Phillips, W.F., and D.A. Bell, Utah State University, Department of Mechanical Engineering, Logan, UT

Diffusion of Radon Gas from Uranium Mill Tailings

Journal of Energy Resources Technology 104(2) :130-133 (1982, June)

A finite element model is presented which predicts radon diffusion in an n-layer composite. The basis functions are obtained from an exact solution to the differential equation for a homogeneous layer. Thus, the model gives the exact solution for n homogeneous layers and, by using many small layers, will give good results for any nonhomogeneous composite. The model can account for diffusion into the soil below the tailings, a finite radon concentration in the ambient atmosphere and a radon source in each layer and the underlying base soil. In addition to the general matrix equation, closed form solutions are presented for some important special cases.

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Pin, F.G., R.D. Sharp, A.J. Witten, and E.C. Long, Oak Ridge National Laboratory, Oak Ridge, TN

A Model for Groundwater Seepage from Mill Tailings Ponds

ORNL-6042; Energy Division Annual Progress Report for the Period Ending September 30, 1983, 192 pp.; (pp. 23-24) (1984, June)

A computer code (MIGRAT) was developed to quantify the migration of moisture and multiple decaying and absorbed contaminants in the unsaturated zone. MIGRAT was specifically conceived to assess the impacts of open mine disposal of uranium mill tailings; however, the code is general enough to allow its use in many problems related to shallow, subsurface waste disposal since it incorporates a number of desirable objectives and user-oriented features. These features include: the capability to simulate one-, two-, or three-dimensional geometries without major coding or input formats; the capability to accurately represent complex geometries and heterogeneous material properties; the capability to simulate systems with diversified and time-variable boundary conditions; the capability to accurately represent the moisture-dependent characteristics of the geological materials; the capability to provide worst-case solutions for contaminants migration, taking into account sorption and decay of contaminants; the use of the discrete cell method in order to explicitly preserve the flux terms as such at the boundary of the cells; and the use of a self-adjusting optimum time step to solve the highly nonlinear equations. (Auth)

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Raghavayya, M., and P.M. Markose, Bhabha Atomic Research Center, Health Physics Division, Jaduguda, India

Experience in Discharge of Uranium Mill Tailings

Advances in Science and Technology of Mineral Beneficiation in India, Proceedings of a Symposium, Hyderabad, India, December 3-5, 1981 (1983)

The radioactive discharge from a uranium mill tailings pond was monitored, and it was determined that the effluent from the tailings pond flowing out into the public domain does not show any undue concentration of toxins. However, the concentrations of discharged radium and manganese need to be decreased.

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Ring, R.J., D.M. Levins, and F.J. Gee, Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sutherland, Australia

Radionuclides in Process and Waste Streams at an Operating Uranium Mill

IAEA-SM-262/26; STI/PUB-622; CONF-820552; Management of Wastes from Uranium Mining and Milling, Proceedings of an IAEA and OECD/NEA International Symposium, Albuquerque, NM, May 10-14, 1982. International Atomic Energy Agency, Vienna, 745 pp.; (pp. 247-261) (1982)

A survey was conducted to determine the distribution of radium-226, lead-210, polonium-210, and thorium-230 in process and waste streams at the Nabarlek Uranium Mill, Australia. Data indicate that about 20% of the thorium-230 is mobilized by leaching in the waste stream; neutralization of the tailings to pH 8.5 removes over 99% of the thorium-230, lead-210, and polonium-210. Unfortunately, neutralization of the tailings increases concentrations of dissolved radium-226.

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Runnells, D.D., C.N. Gerlitz, A. Davis, R.D. Lindberg, and R. Meglen, University of Colorado, Boulder, CO

Contamination of Ground and Surface Waters by Uranium Mining and Milling, Volume 3: Experimental Studies and Analytical Procedures, Open File Report, July 25, 1979-September 14, 1981

PB-84-172204; 230 pp. (1983, September 15)

The objective of this study was to measure the degree of retardation of the important chemical species in fluid from a uranium tailings pile as the fluid passed through cores taken from rock underlying the tailings pile. The measurements indicated that pH was the dominant control on the behavior of these species, and that the pH was affected primarily by the calcite cement in the rocks. The most appropriate species for monitoring were sulfate, chloride, and selenium. An appendix provides a description of the advantages and disadvantages of the various analytical procedures used on these high-ionic strength solutions.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT ENVIRONMENTAL STUDIES AND SITE SURVEYS

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Scarano, R.A., and E.D. Harward, U.S. Nuclear Regulatory Commission, Washington, DC

Current Uranium Mill Licensing Issues: Methods for Measuring Radiation in and Around Uranium Mills

CONF-770581; Methods for Measuring Radiation in and Around Uranium Mills, Proceedings of a Workshop, Albuquerque, NM, May 23-26, 1977. Atomic Industrial Forum, Inc., Washington, DC, 434 pp.; (pp. 35-51) (1977)

The problems encountered to insure environmentally safe mining and milling of uranium ores are reviewed. Emphasis is placed on the management of tailings resulting from milling operations. It is pointed out that although the concentration of radioactivity in the tailings is relatively low, control measures are necessary because of the large quantities involved and because of the long half-life of the parent radionuclides present. The major concerns with mill tailings are radon release to the atmosphere and isolation of the tailings from the human environment. Since it is anticipated that the amount of tailings created by the year 2000 will be more than an order of magnitude greater than the quantities that have been generated during the past 30 years, it is recommended that all mill tailings storage areas be located remote from public contact and in areas such that disruption and dispersion by natural forces and seepage of toxic materials into ground water systems are reduced to the maximum extent achievable. Technical issues that receive attention during the NRC licensing process for uranium mills and the preparation of environmental impact statements are discussed briefly. (Auth)(PTO)

549
Schumm, S.A., J.E. Costa, T. Toy, J. Knox, R. Warner, and J.G. Scott, Colorado State University, Fort Collins, CO

Geomorphic Assessment of Uranium Mill Tailings Disposal Sites

Uranium Mill Tailings Management, Proceedings of Two OECD/DOE Workshops, Fort Collins, CO, October 28-30, 1981. Organization for Economic Cooperation and Development, Paris, 237 pp.; (pp. 69-79) (1982)

A geomorphic evaluation of uranium mill tailings disposal sites consists of assessing control on site stability and determining how principles of geomorphology are applied properly. Within certain landscapes there are areas that are more favorable to long-term disposal of radioactive tailings than others. Some locations are geomorphologically unsuitable because of landform changes or inundation by severe hydrologic events.

550
Sharma, H.D., and M. Kalin, University of Waterloo, Guelph-Waterloo Center, Waterloo, Ontario, Canada

Lead-210 and Total Lead Uptake in Plants Growing on Abandoned or Inactive Uranium Mill Tailings

AECL-7760; CONF-8205253; Proceedings of the Third Annual Canadian Radiation Protection Association Meeting, Vancouver, British Columbia, Canada, May 4, 1982; (pp. D8-D14) (1982)

The authors present data on the uptake of Pb-210 in plants growing on abandoned or inactive uranium mill tailings. The ratio of Pb-210 to total lead is calculated both in the plant samples and mill tailings to give indications of absorption.

551
Shoesmith, D.W., Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, Canada

Behaviour of Radium in Soil and in Uranium Mine-Tailings

AECL-7818; 75 pp. (1984, September)

The existence of a number of historical wastes has prompted the need to develop a disposal strategy for material contaminated with radium-226. This report reviews the pertinent radiological and chemical properties of radium, in particular, the solubility of its salts, its ability to complex, its adsorption behavior, and how these properties compare with those of the other members of the alkaline earth series. Chemical factors that determine the mobility of radium in soil/groundwater

environments are discussed. Adsorption on clays, minerals and organic matter, and coprecipitation are the main processes that inhibit radium mobility. Soil leaching studies are reviewed. The largest potential source of radium in the environment is the leaching of uranium mine-tailings. Therefore, the mineralogy of mine-tailings and attempts to leach them are reviewed. Radium levels in leached residues are compared to the standards for radium levels, and realistic targets are suggested for leaching methods. Techniques for scrubbing soil, immobilizing radium, and treating wastewater containing radium are reviewed. Finally, recommendations are made for a possible leaching strategy for radium-contaminated soil, and for further research to develop an effective disposal strategy.

552

Shuman, R., Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO

Intrusion of Soil Covered Uranium Mill Tailings by Whitetail Prairie Dogs and Richardson's Ground Squirrels

DOE/EV-10305-14; 83 pp. (1984)

The primary objective of the reclamation of uranium mill tailings is the long-term isolation of the material from the biosphere. Fossorial and semi-fossorial species represent a potentially disruptive influence as a result of their burrowing habits. The potential for intrusion was investigated with respect to two sciurids, the whitetail prairie dog (Cynomys leucurus) and Richardson's ground squirrel (Spermophilus richardsonii). Populations of prairie dogs were established on a control area, lacking a tailings layer, and two experimental areas, underlain by a waste layer in southeastern Wyoming. Weekly measurements of prairie dog mound surface activities were conducted to demonstrate penetration, or lack thereof, of the tailings layer. Additionally, the impact of burrowing upon radon flux was determined. Limited penetration of the waste layer was noted after which frequency of inhabitance of the intruding burrow system declined. No significant changes in radon flux were detected. In another experiment, it was found that Richardson's ground squirrels burrowed to less extreme depths when confronted by mill tailings. Additional work at an inactive tailings pile in western Colorado revealed repeated intrusion through a shallow cover, and subsequent transport of radioactive material to the ground surface by prairie dogs. Radon flux from burrow entrances was significantly greater than that from undisturbed ground. Data suggested that textural and pH properties of tailings material may act to discourage repeated intrusion at some sites.

553

Silver, M., and J.B. Taylor, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Assessment of the Microbial Populations in Field and Test Pit Experiments at Elliot Lake, Ontario, Canada

MRP/MSL-81-17; 33 pp. (1981, January)

Enumeration of aerobic and anaerobic heterotrophic (organic carbon-using) bacteria shows the establishment of a microbial population on vegetated tailings. The development of a population of heterotrophic bacteria, 90% of which are obligate aerobes, in the top 5 cm of the tailings is indicative of normal soil formation. The cell concentration decrease is greater than that found in older, well-developed soils. Iron-oxidizing thiobacilli are rarely present in the revegetated tailings, and then only at depths below 40 cm and at cell concentrations less than 100 cells/g. On an adjacent unvegetated portion of the tailings, fewer heterotrophic bacteria are found in the top 5 cm of the tailings. Iron-oxidizing thiobacilli are present uniformly in the top 47 cm. Enumeration of iron-oxidizing bacteria in the effluents of four test pit experiments indicate blockage of the drainage tiles in two experiments. Chemical conditions of the effluents are suitable for the formation of basic ferric precipitates that could cause this blockage.

554

Skinner, D.J., and F.W. Whicker, Colorado State University, Fort Collins, CO

Ra-226 Contamination Dispersed from Uranium Mill Tailings on to Soil and Sagebrush

Health Physics 47(1):199; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT ENVIRONMENTAL STUDIES AND SITE SURVEYS

The problem of windblown tailings material and extent of contamination is significant to the uranium industry. When decommissioning activities begin at the end of a mill site's productive lifetime, the extent of windblown contamination must be considered due to the potential cost impact on closure requirements. Because of the importance of this problem, the Department of Energy and Colorado State University collaborated to fund a study investigating the dispersion of uranium tailings into the environment. This specific study quantified Ra-226 contamination of soil and foliage (Artemisia tridentata) as a function of distance downwind (0-6.6 km) from a uranium mill tailings pipe. In soils the radium contamination was primarily associated with particle sizes less than 0.045 mm and mainly found within the 0.06 cm soil horizon. In most soil samples, Ra-226 concentrations approached background levels at a distance of 1.1 km from the tailings pipe. In sagebrush samples, Ra-226 approached background values between 3.3 km and 6.6 km. Trends of activity versus distance are discussed for Ra-226 concentrations in soil and sagebrush. (Auth)

555

Sreger, H.F., and C.W. Smith, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Uranium Tailings Samples UTS-1 to UTS-4 of CCRMP

Geostandards Newsletter 8(1):57-59 (1984)

The Canadian Certified Reference Materials Project announces the availability of reference uranium tailings samples UTS-1, -2, -3, and -4. Eighteen laboratories participated in the interlaboratory program for analysis of total iron, titanium, aluminum, calcium, barium, uranium, thorium, total sulfur, sulfate, and arsenic. Eight laboratories participated in the interlaboratory program for thorium-230, radium-226, lead-210, and polonium-210 in all four samples and for thorium-232, radium-228, and thorium-228 in UTS-1 and UTS-2.

556

Torma, A.E., I.H. Gundiler, D.J. Kirby, J.J. Santana, and S.Y. Yen, New Mexico Institute of Mining and Technology, Mineral Institute, Socorro, NM

Hydrochloric Acid Leaching of a Low-Grade New Mexico Uranium Ore

Metall 37(2):148-152 (1983, February)

The present work reports on kinetic data of hydrochloric acid leaching of a low-grade uranium ore and on the preliminary information regarding the removal of radium-226 and thorium-230 from the leach residues. The importance of environmentally and radiochemically safe tailings is discussed.

557

Whicker, F.W., and S.A. Ibrahim, Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO

Radioecological Investigations of Uranium Mill Tailings Systems, Fifth Technical Progress Report, October 1, 1983-September 30, 1984

DOE/EV-10305-15; 51 pp. (1984, October 15)

The general intent of this investigation is to quantitatively evaluate the potential release of important radionuclides from active and reclaimed uranium mill tailings and their entry into the food chain. For active mill tailings, we are trying to quantify the degree of escape and dispersal, primarily by wind, and to measure the accumulation of U-238, Th-230, Ra-226, Pb-210, and Po-210 by various native plants. Of particular interest are the relationships between soil and vegetation at different sites, since the chemical environment of areas impacted by mill tailings is drastically different than undisturbed natural areas. Also of great interest is the relative importance of various mechanisms of radionuclide accumulation by plants, such as root uptake and aerial deposition followed by some degree of foliar absorption. This investigation includes as a major component studies relating to the final disposal of mill tailings. An experimental plot was developed in which a slab of uniform tailings was covered with various depths of earthen materials and seeded with native range vegetation. Experiments on radon flux versus overburden depth have been conducted and continuing studies are planned. The influence of overburden depth on uptake of radionuclides by native plants is also under study. Work relating to the ability of roots to penetrate tailings or to function near a soil-tailings interface is being carried out. Data on the effect of barium chloride treatment of uranium ore indicate significant reduction of the Rn-222 emanation fraction in simulated mill tailings and reduced Ra-226 leachability. Soil spiked by injecting radionuclides into the root zone of mature sagebrush was used to obtain data on root uptake for Ra-226, Pb-210, and Po-210.

558

Wiles, D.R., Carleton University, Chemistry Department, Ottawa, Ontario, Canada

Radiochemistry of Radium and Thorium in Uranium Mine Tailings

Water, Air, and Soil Pollution 20(1):99-108 (1983, July)

The chemical leaching of radium and thorium from uranium mine tailings at Beaverlodge, Canada has been studied as part of an investigation into determining the chemical and mineralogical placement of these radionuclides in the tailings particles. A mathematical model is described which combines these two processes and accounts for the experimental data.

559

Zelle, P.W., N.D. Kretz, D.R. Rayno, and W.E. Kisieleski, Argonne National Laboratory, Division of Environmental Impact Studies, Argonne, IL

Gamma-Ray System for Field Analysis of Ra-226 in Soil

Health Physics 43(1):96 (1982)

The EPA-recommended upper limit for average Ra-226 concentrate in soil subsequent to uranium mill tailings remedial action is 5 pCi/g. To direct a tailings remedial action project, a cost-effective method of soil analysis is needed to identify areas where Ra-226 contamination exceeds this limit. Requirements of such a system would be: sufficient sensitivity to insure compliance with the standard, adaptability for operation in the field, and the ability to respond rapidly to an ongoing cleanup operation. A system has been developed using gamma-ray analysis of soil samples to identify Ra-226 contamination. Samples containing a known amount of Ra-226 added to flint shot sand are used to calibrate the system. Spectral stripping is applied to correct Ra-226 measurements for Th-232 series contamination. The counting system is interfaced with a microcomputer, and software is being developed for sample analysis. Estimates were 4.0% and 16.4% higher than the NBS determinations. Data from samples taken in the vicinity of inactive uranium tailings sites are presented. An environmental monitoring protocol for conducting Ra-226 measurements during remedial action and certification of UMTRA sites is discussed.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT HEALTH, SAFETY, AND BIOMEDICAL STUDIES

560

Dory, A.B., Atomic Energy Control Board, Ottawa, Ontario, Canada

Regulatory Process for Uranium Mines in Canada - General Overview and Radiation Health and Safety in Uranium Mine-Mill Facilities

INFO-0082; CONF-8106326; Proceedings of an Uranium Inquiry Meeting, Halifax, Nova Scotia, Canada, June 22, 1981()

This presentation is divided into two main sections. In the first, the author explores the issues of radiation and tailings disposal, and then examines the Canadian nuclear regulatory process from the point of view of jurisdiction, objectives, philosophy, and mechanics. The compliance inspection program is outlined, and the author discusses the relationships between the AECB and other regulatory agencies, the public, and uranium mine-mill workers. The section concludes with an examination of the stance of the medical profession on nuclear issues. In part two, the radiological hazards for uranium miners are examined: radon daughters, gamma radiation, thoron daughters, and uranium dust. The author touches on new regulations being drafted, the assessment of past exposures in mine atmospheres, and the regulatory approach at the surface exploration stage. The presentation concludes with the author's brief observations on the findings of other uranium mining inquiries and on future requirements in the industry's interests.

561

Marks, S., Pacific Northwest Laboratory, Richland, WA

Uranium Mill Tailings and Health Risks

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

Projected health effects for persons exposed to mill tailings at vicinity properties can be estimated in terms of either the individual's cancer risk or the collective cancer risk for a structure, based on its occupancy. Such estimates are potentially useful in establishing priorities for cleanup and in reevaluating standards. The current revision of exposure and dose estimates for the Hiroshima and Nagasaki survivors will eventually result in reconsideration of the gamma-ray standard by the National Council on Radiation Protection and Measurements and International Commission on Radiological Protection; any revision is not likely to be drastic. The continuing epidemiologic study of Hanford workers has disclosed no new results in the most recent updated analysis. (Auth)

562

Marks, S., F.T. Cross, D.H. Denham, and W.E. Kennedy, Jr., Pacific Northwest Laboratory, Richland, WA

Current Views on Health Effects of Uranium Mill Tailings

CONF-831047; *Proceedings of an American* Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (p. 46); Transactions of the American Nuclear Society 45:46 (1983, November 3)

Uranium mill tailings at active mills are subject to regulatory control. This will serve to limit potential adverse impacts which they may have on human health. Tailings at abandoned mill sites and tailings that were transported for use away from active mills before there was recognition of their potential health hazards pose a more serious problem. It is here that remedial action has been mandated by federal statute. Priorities must be established for the cleanup of these individual sites or properties. Estimation of the magnitude of the health risk at individual locations becomes an important factor in determining the need for such action. A discussion is presented of various aspects of the health risk problems including methods to estimate health effects resulting from mill tailings.

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Morrison, B.J., University of British Columbia, Department of Health Care and Epidemiology, Vancouver, British Columbia, Canada

Health Effects of Uranium Mining and Milling and Waste Disposal

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT HEALTH, SAFETY, AND BIOMEDICAL STUDIES

CONF-8005177; CONF-8005194; Uranium Mine Waste Disposal, C.O. Brawner, (ed.), Proceedings of the First International Conference, Vancouver, British Columbia, Canada, May 19-21, 1980. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Society of Mining Engineers, New York, NY, 626 pp.; (pp. 11-18) (1980)

There is little documented evidence of the effects of low-level radiation. This is not to say that the evidence is negative, it is just sparse and inconclusive. There are only 3 major data sources from uranium mining operations. These operations are in Ontario, Czechoslovakia and the Colorado-Utah area. There are two other sources of data for radon exposure of miners. One is from the fluorospar mines in Newfoundland and the other is the iron and the zinc mines in Sweden. Only a small portion of this data relates to low-level exposure, unfortunately; most of it relates to workers who received a total of 400 or more Working Level Months (WLM) during their lifetime. Because of the long latent period (up to 40 years) from first exposure to the diagnosis of lung cancer, the miners who entered the industry, in the '40's and '50's when the radon levels in the mines were very much higher, are the ones on whom the present statistics are based. Also, in many cases the actual radon levels of this period are not known; they are only estimated, since routine measurements were not often taken. Another problem relating to assessing the effects of low-level radiation is the "confounding" effect of smoking. The majority of miners smoke so it is difficult to assess what proportion of the lung cancer cases can be attributed to smoking. Although we have estimates of the increased risk for smokers, these estimates have been derived from groups which were not miners. Because there may be a synergistic effect between smoking and radiation it may not be legitimate to apply these estimates to the miners. In contradiction to the Colorado-Utah analyses, the Swedish results indicate that smoking has a protective effect, that it may even halve the lung cancer rate. Obviously, more complete and recent low dose data will have to be collected before firm estimates of lung cancer risks can be established. However, it does appear from the sparse data available that for low lifetime exposures the radiation induced lung cancer risk is not large. (Auth)

534

Rayno, D.R., Argonne National Laboratory, Argonne, IL

Estimated Dose to Man from Uranium Milling via the Beef/Milk Food-Chain Pathway

Science of the Total Environment 31(3):219-241 (1983, December 1)

One of the major pathways of radiological exposure to man from uranium milling operations is through the beef/milk food chain. Studies by various investigators have shown the extent of uptake and distribution of U-238, U-243, Th-230, Ra-236, Pb-210, and Po-210 in plants and cattle. These long-lived natural radioisotopes, all nuclides of the uranium decay series, are found in concentrated amounts in uranium mill tailings. In this paper, data from these investigations are used to estimate the dose to man from consumption of beef and milk from cattle that have fed on forage contaminated with the tailings. The estimated doses from this technologically enhanced source are compared with those resulting from average dietary intake of these radionuclides from natural sources.

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Ruttenber, A.J., Jr., K. Kreiss, R.L. Douglas, T.E. Buhl, and J. Millard, Georgia Department of Health and Human Services, Atlanta, GA

Assessment of Human Exposure to Radionuclides from a Uranium Mill Tailings Release and Mine Dewatering Effluent

Health Physics 47(1):21-35 (1984, July)

This study provides an assessment of human exposure to radiation from a river system contaminated by radionuclides of the U-238 decay series released through a dam break at a uranium mill tailings pond and by the continuous discharge of dewatering effluent from 2 uranium mines. The in vivo analyses of radionuclides in 6 Navajo Indians who lived near the river indicate no detectable elevations above background concentrations. Dose estimates for inhalation of suspended river sediment indicate a maximum annual 50-yr dose commitment of 204 mrem to the endosteum. Estimates of doses (50-yr dose commitments) from the ingestion of livestock range between 1 mrem (to liver) and 79 mrem (to bone) and suggest that the major contribution to human exposure is from mine dewatering effluent that has been continuously released into the river system for many years.

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U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

Potential Health and Environmental Hazards of Uranium Mine Wastes: Draft Report

Draft Report (1979, September)

This report identifies the location and potential health, safety, and environmental hazards of uranium mine wastes. Following are conclusions with recommendations on airborne, aqueous, and solid wastes from active and inactive mines. The airborne radioactive particulate source term at active surface mines shoud be confirmed by field studies. Estimates of Rn-222 releases at in-situ leach mines during the leaching and restoration processes indicate a potential health hazard. Since a population may be exposed to releases from more than one mine, consideration should be given to modeling releases from multiple mine sites. The major potential airborne health hazard at inactive mines results from Rn-222 emissions, therefore all portals and vents of inactive underground mines should be sealed. This will reduce Rn-222 emissions by about 96%. Emissions from abandoned spoils piles should be further evaluated to determine the need for possible federal statute remediation. Available monitoring data should be reviewed giving special attention to potential drinking water pathways, and changes recommended in NPDES parameters and limits, as necessary. Concentrations of radioactive and nonradioactive nuclides in water from wells within the areas that are potential sources of drinking water should be monitored. Field studies and/or a literature review should be performed to predict the stochastic flow patterns for assessment area streams. Comprehensive water quantity and quality investigations are needed to develop the technical basis for any needed revisions in regulating uranium mine dewatering. An analysis of the cumulative effects of multiple operations on doses and potential health effects due to aqueous releases should be performed. Water in abandoned surface mine pits should be monitored. Proposed regulations for solid wastes should be adequate, and no recommendations are made. Conclusions are that: additional data should be developed to determine the extent and significance of erosion and need for reclamation; adequate drill hole plugging should be required and enforced; and a complete, updated listing of active uranium mines should be developed. (CAJ)

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U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

Potential Health and Environmental Hazards of Uranium Mine Wastes, Executive Summary

EPA-520/1-6-83-007; 24 pp. (1983, June 10)

This report analyzes the potential health and environmental impacts of both active and inactive uranium mines, lists the locations of these mines, identifies additional information needs, and recommends needed actions. A generic assessment based on mathematical models of representative facilities, classed by type and size of operation, is presented. Realistic but conservative parameters which tend to overestimate potential environmental impacts were used in the assessment. This Executive Summary contains a brief description of material presented in the main text. (BDC)

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Yuan, Y.C., and C.J. Roberts, Argonne National Laboratory, Division of Environmental Impact Studies, Argonne, IL

Comparative Assessment of Radiological Impact from Uranium and Thorium Milling

IAEA-SM-262/17; STI/PUB-622; CONF-820552; Management of Wastes from Uranium Mining and Milling, Proceedings of an IAEA and OECD/NEA International Symposium, Albuquerque, NM, May 10-14, 1982. International Atomic Energy Agency, Vienna, 745 pp.; (pp. 505-519) (1982)

Sources and exposure pathways associated with transport of radon and thoron gases and particulate materials containing uranium and thorium and their decay products from a reference uranium mill and a thorium mill are described. Potential radiological impacts resulting from operation of the mills are summarized and compared. Individual exposures are evaluated relative to the limit of 25 mrem per year imposed by the U.S. Environmental Protection Agency uranium fuel cycle standard, 40 CFR 190. Calculations indicate that this limit might not be met within about 3 km downwind from either the model uranium or thorium mill. The results of this assessment also indicate that radiation protection standards that limit individual doses from radon and thoron should be established. (Auth)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT DECONTAMINATION STUDIES

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Ibrahim, S.A., and S.L. Flot, Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO

Effects of Barium Chloride Treatment of Uranium Mill Tailings and Ore on Radon Emanation and Ra-226 Levels - Progress Report

DOE/EV-10305-12; 63 pp. (1983, November 30)

The purpose of this study was to investigate the effect of barium chloride treatments on: reduction of Rn-222 emanation from mill wastes; reduction of Ra-226 levels in wastewater; and decreased leachability of Ra-226 from mill wastes. Baseline Ra-226 concentrations were determined for ore and tailings as well as radon emanation fractions. Uranium ore was treated with soluble barium at concentrations of 10, 25, 50, and 100 mg/l of slurry. The leach-liquor declined in Ra-226 concentration by as much as 50%. When soluble potassium as well as barium was used in the treatment process at equal concentrations of 10, 25, 50, and 100 mg/l of slurry, a similar reduction was observed. No significant difference was noted between the two treatment regimes. An accelerated leaching experiment was performed on the ore treated with barium chloride. All treatment groups except that treated with 10 mg/l (soluble barium) of slurry showed significant decreases in leachability. Available Rn-222 (corresponds with radon emanation fraction) was measured in treated and untreated ore. Ore treated with concentrations of barium up to 1.00 mg per gram of ore did not show a statistically significant reduction in available Rn-222, however when potassium sulfate was also added, a significant decline was noted. This study suggests that barium chloride treatments reduce radon emanation from mill wastes and reduce Ra-226 levels in wastewater. Leachability of Ra-226 from treated samples decreased markedly.

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Lakshmanan, V.I., and I.J. Itzkovitch, Eldorado Nuclear Limited, Ottawa, Ontario, Canada

Bench Scale Evaluation and Economic Assessment of Ion Exchange Resins for the Removal of Radionuclides from Uranium Mill Tailings Effluents

INIS-mf-9492; 47 pp. (1981, July)

Stirred tank tests were used to screen potential solid ion exchangers for detailed testing in columns. Column tests on selected exchangers were carried out to determine breakthrough curves as a function of column throughput. An economic assessment of the process was carried out. Results obtained indicate that removal of soluble radium-226 to less than 3 pCi/l by ion exchange is technically feasible. However, if the solid exchangers are to be used on a once-through basis the process is prohibitively expensive.

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Landa, E.R., U.S. Geological Survey, Reston, VA

Leaching of Molybdenum and Arsenic from Uranium Ore and Mill Tailings

Hydrometallurgy 13(2):203-211 (1984, December)

While the most attention to environmental hazards associated with uranium mill tailings has focused on radionuclides, increasing attention is being paid to toxic, non-radioactive elements present in the tailings. Molybdenum (Mo) and arsenic (As) are trace elements commonly associated with uranium deposits. A sequential, selective extraction procedure was used to assess the effects of sulfuric acid milling on the geochemical associations of molybdenum and arsenic in a uranium ore blend, and the tailings derived therefrom. The milling process removed about 2? % of the molybdenum and 53% of the arsenic initially present in the ore. While about one-half of the molybdenum in the ore is water soluble, only about 14% existed in this form in the tailings. The major portion of the extractable molybdenum in the tailings appears to be associated with hydrous oxides of iron, and with alkaline earth sulfate precipitates. In contrast with the pattern seen for molybdenum, the partitioning of arsenic into the various extractable fractions differs little between the ore and the tailings. (Auth)(JWF)

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Levins, D.M., and R.K. Ryan, Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sutherland, Australia

Leaching of Radium-226 from Uranium Tailings

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT DECONTAMINATION STUDIES

IAEA/HSW/11; Waste Management Research Abstracts (11):47-48 (1976)

The principal waste arising from acid leaching of uranium ores is a slurry consisting of a mixture of tailings and acidic raffinate. This slurry is impounded, possibly after neutralization, in a tailings retention system. The subsequent natural leaching of radium from these tailings is important because water seeping from the retention system could become a source of ground-water pollution. A systematic study of the factors affecting the leachability of radium-226 from tailings is being undertaken in order to propose a mechanism for leaching. Batch experiments are being conducted in a 2-liter agitated vessel. Major findings are as follows: initial release of radium from tailings is very rapid occurring within one minute; equilibrium is established between solution and tailings in about one hour; significant quantities of radium can be leached by contact of tailings with large volumes of water; and high sulfate concentrations tend to retard the release of radium. (Auth)(PTO)

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Radium in Uranium Mill Tailings - Some Observations on Retention and Removal

Hydrometallurgy 12(2):151-176 (1984)

The various mechanisms by which radium can be retained by uranium mill tailings are discussed. These include coprecipitation (solid solutions), adsorption on silica and hydroxides, ion exchange in clay minerals, and retention in pores. Previous work on radium removal from mill tailings and on radioactive disequilibrium in uranium deposits is critically reviewed in relation to these mechanisms. Fresh data are presented, indicating roles of charge-depressant ions and of organic complexing agents in radium removal. The addition of reducing agent has been found effective in the presence of complexing agents because it can convert some low-solubility metal hydroxides to their more soluble, lower valency form, thereby eliminating radium adsorption sites. A radium level of 30 pCi/g in the tailings is concluded to be environmentally safe for surface disposal of the tailings. (Auth)

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Raicevic, D., and M. Raicevic, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Preconcentration of a Low-Grade Uranium Ore Yielding Tailings of Greatly Reduced Environmental Concerns: Part 5 - CPDU Investigation of Agnew Lake Ore - 0.057 Percent Uranium

MRP/MSL-80-166; 26 pp. (1980, November)

The low-grade ore sample used for this investigation contained 0.057 percent uranium with uranothorite as the major uranium-bearing mineral and a small amount of brannerite, occurring in the quartz-sericite matrix of a conglomerate. The preconcentration procedures, consisting of pyrite flotation with or without flotation of radioactive minerals, followed by high intensity wet magnetic treatment of the sized flotation tailings, produced pyrite and radioactive concentrates of acceptable uranium grades ranging from 0.1 to 0.135 percent uranium. The combined concentrates comprised 37 to 49 percent of the ore by weight with the following combined recoveries: 95.6 to 97.9 percent of the uranium; 94.7 to 96.3 percent of the radium; 97.8 to 99.3 percent of the thorium; and over 98 percent of the pyrite. The preconcentration tailings produced comprised between 51 and 63 percent of the ore by weight and contained from: 0.0022 to 0.0037 percent U; 12 to 17 pCi/g Ra; 0.002 to 0.004 percent Th; less than 0.03 percent S. Because these tailings are practically pyrite-free, they should not generate acidic conditions. Due to their low radium content, their radionuclide hazards are greatly reduced. These preconcentration tailings therefore, could be suitable for surface disposal, mine backfill, revegetation or other uses.

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Scheitlin, F.M.

Removal of Radium from Acidic Solutions Containing Same by Adsorption on Coal Fly Ash

U.S. Patent 4,431,609 (1984)

The invention is a process for the removal of radium from acidic aqueous solutions. In one aspect, the invention is

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT DECONTAMINATION STUDIES

a process for removing radium from an inorganic-acid solution. The process comprises contacting the solution with coal fly ash to effect adsorption of the radium on the ash. The radium-containing ash then is separated from the solution. The process is simple, comparatively inexpensive, and efficient. High radium-distribution coefficients are obtained even at room temperature. Coal fly ash is an inexpensive, acid-resistant, high-surface-area material which is available in large quantities throughout the United States. The invention is applicable, for example, to the recovery of Ra-226 from nitric acid solutions which have been used to leach radium from uranium-mill tailings.

576

Torma, A.E., New Mexico Institute of Mining and Technology, Department of Metallurgical and Materials Engineering, Socorro, NM

New Approach to Uranium Mill Tailings Management: Final Report, January 1, 1981-June 30, 1982

NMERDI-2-69-1308; 46 pp. (1983, November)

The purpose of this research project is to demonstrate the possibility of development of efficient leaching processes for the extraction of uranium from low-grade ores and for the removal of long half-life radionuclides (radium-226) from the leach residues in order to produce radiochemically innocuous tailings. The present investigation is the second part of a three-year project. It provides kinetic information not heretofore available for uranium leaching by hydrochloric and sulfuric acid solutions and initial data for the extraction of Ra-226 from the leach residues by brine solutions. Preliminary data on the removal of Ra-226 from neutralized tailing effluents and leach solutions with commercially available solid organic ion exchangers are discussed. A generalized mathematical form has been developed for the initial rate of uranium extraction as a function of the leaching parameters using experimental data and a linear regression computation technique.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT SITE STABILIZATION AND RECLAMATION

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Beedlow, P.A., and J.N. Hartley, Pacific Northwest Laboratory, Richland, WA

Long-Term Protection of Uranium Mill Tailings

DOE/UMT-0218; PNL-4984; 1 p. (1984, April)

U.S. Environmental Protection Agency standards for the cleanup and disposal of inactive tailings sites require that control measures for disposal of tailings be designed to be effective for up to 1,000 years if reasonably achievable or, at the least, for 200 years. To control the escape of contaminants over such long periods, containment systems must be capable of adjusting to changing environmental conditions. Elements of a containment system include surface covers, biotic barriers, radon barriers, and, in some cases, liners. Each element of the system affects the others, and the whole system responds to the surrounding environment. Interaction is facilitated primarily by soil moisture. Consequently, the control of soil moisture is critical to the effectiveness of containment systems. Protective covers are necessary to prevent disruption of the containment system by physical or biological factors, to provide for the effective functioning of the radon barriers, and to prevent infiltration of excess water that could cause leaching. In order to design protective covers, a working knowledge of the factors and processes impacting tailings piles is required. This report characterizes the major factors and processes and presents generic solutions based on current research. (Auth)

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Beedlow, P.A., and G.B. Parker, Pacific Northwest Laboratory, Richland, WA

Designing Protective Covers for Uranium Mill Tailings Piles: A Review

NUREG/CR-4075; PNL-5323; 29 pp. (1985, May)

This report reviews design considerations for protective covers for uranium mill tailings impoundments. The role of protective covers in tailings containment is discussed. Factors affecting the long-term stabilization of tailings (erosion, biotic intrusion, and soil moisture) are summarized. Basic elements to be considered in design of all uranium tailings covers are presented, and then quantitative techniques for designing site-specific covers are reviewed. (Auth)

579

Boegly, W.J. Jr., T. Tamura, and J.D. Williams, Oak Ridge National Laboratory, Oak Ridge, TN; Y-12 Plant, Oak Ridge, TN

Grouting of Uranium Mill Tailings Piles

CONF-8406205; Environmental Engineering, Proceedings of the 1984 National Conference, Los Angeles, CA, June 25, 1984()

A program of remedial action was initiated for a number of inactive uranium mill tailings piles. These piles result from mining and processing of uranium ores to meet the nation's defense and nuclear power needs and represent a potential hazard to health and the environment. Possible remedial actions include the application of covers to reduce radon emissions and airborne transport of the tailings, liners to prevent groundwater contamination by leachates from the piles, physical or chemical stabilization of the tailings, or moving the piles to remote locations. Conventional installation of liners would require excavation of the piles to emplace the liner; however, utilization of grouting techniques, such as those used in civil engineering to stabilize soils, might be a potential method of producing a liner without excavation. Laboratory studies on groutability of uranium mill tailings were conducted using samples from three abandoned piles and employing a number of particulate and chemical grouts. These studies indicate that it is possible to alter the permeability of the tailings from ambient values of 10(E-3) cm/s to values approaching 10(E-7) cm/s using silicate grouts and to 10(E-8) cm/s using acrylamide and acrylate grouts. An evaluation of grouting techniques, equipment required, and costs associated with grouting were also conducted and are presented.

580

Canterford, J.H., and G.J. Sparrow, Commonwealth Scientific and Industrial Research Organization, Division of Mineral Chemistry, Port Melbourne, Australia

Use of Measured Dewatering Characteristics in the Design of Uranium Tailing Management Systems

CONF-8309275; Water Regime in Relation to Milling, Mining and Waste Treatment Including

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Rehabilitation with Emphasis on Uranium Mining, Proceedings of an International Specialist Conference, Darwin, Australia, September 4, 1983 (1983, September 4)

The dewatering characteristics of tailings from two uranium mining operations were determined and used to calculate in one case the extent and in the other the rate at which the tailings may be consolidated. The calculations were carried out using the theory developed to describe the movement of water in swelling media. Uranium tailings are commonly retained in a dam after stage thickening to remove the leach residue from the uranium leachate. The equilibrium moisture ratio for tailings in a dam was calculated; this permitted an estimate of the volume of the tailings to be made, and in turn, the space remaining in the dam. An alternative approach to tailings stabilization is to discharge the thickened tailings into a shallow pond on the ground. The times required to dewater tailings to the solid state for a range of initial tailing depths have been calculated and used to estimate the minimum period between successive pondings. This approach can only be used successfully in certain climatic regimes. Using the types of calculations described in this paper, the final properties of the tailings can be estimated. These allow a realistic management scheme to be formulated.

581

Charlie, W.A., D.O. Doehring, D.S. Durnford, and J.P. Martin, Colorado State University, Department of Civil Engineering, Fort Collins, CO

Dewatering Tailings Impoundments: Interior Drains

CONF-06239; Proceedings of the Seventh Panamerican Conference on Soil Mechanics and Foundation Engineering, PAN AM '83, Vanccuver, British Columbia, Canada, June 1983; (pp. 807-817) (1983, June)

For the design of a new uranium tailings impoundment in the western United States, it was proposed that an interior drainage system be considered to economically and reliably minimize potential short- and long-term environmental impacts. The objectives were to decrease the effective hydraulic head on the clay liner, to dewater and stabilize the tailings, and to increase the amount of water recycled to the mill. This paper presents saturated and unsaturated seepage principles and reviews the concept, criteria and design of the various interior drainage systems considered.

582

Dodson, M.E., B.E. Opitz, and D.R. Sherwood, Pacific Northwest Laboratory, Richland, WA

A Two-Reagent Neutralization Scheme for Controlling the Migration of Contaminants from a Uranium Mill Tailings Disposal Pond

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 401-410) (1985)

Techniques for reducing contaminant migration from tailings liquor impoundments and evaporation ponds are being investigated by the Pacific Northwest Laboratory as part of the U.S. Nuclear Regulatory Commission's Uranium Research and Recovery Program. Building upon previous studies investigating single-reagent neutralization, laboratory experiments were conducted to evaluate the performance of a two-reagent neutralization scheme for the treatment of acidic uranium mill tailings liquors. Acidic tailings liquor, pH less than 2.0, was initially neutralized with limestone to an intermediate pH of either 4.0 or 5.0, followed by hydrated lime neutralization to pH 7.3. Solution analyses determined that CaCO3 neutralization to pH 4.0 followed by continued neutralization with lime to pH 7.3, resulted in the highest solution quality with respect to the U.S. Environmental Protection Agency's water quality guidelines. Furthermore, the two-reagent neutralization scheme is the most cost-effective treatment procedure tested to date. (Auth)

583

Dreesen, D.R., E.J. Cokal, L.E. Wangen, J.M. Williams, and E.F. Thode, Los Alamos National Laboratory, Environmental Science Group, Los Alamos, NM; New Mexico State University, Department of Management, Las Cruces, NM

Thermal Stabilization of Uranium Mill Tailings

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT SITE STABILIZATION AND RECLAMATION

Environmental Science and Technology 18(9):658-667 (1984, January)

The treatment of uranium mill tailings by high-temperature sintering (greater than 1050 degrees C) has been investigated as a means of controlling the release of Rn-222 and leachable contaminants. Thermal stabilization in laboratory trials at 1200 degrees C reduced the radon emanation of various tailings by factors ranging from 37 to 1400 depending on the minerology of the tailings. The leachability of most contaminants (e.g. Al, Cd, Mn, Pb, U, and Zn) was substantially reduced. The weathering of thermally stabilized tailings was simulated by grinding and leaching and appears dependent on the gypsum content and particle size distribution of the original tailings as well as the amount of amorphous material produced during thermal treatment. Pilot-scale thermal stabilization tests verified the technical feasibility of this conditioning process. A conceptual engineering design of a thermal stabilization operation has been developed around the use of coal-fired rotary cement kilns; economic analysis of remedial action alternatives at several inactive uranium processing sites indicates that the cost of thermal stabilization is comparable to relocating the tailings piles. (Auth)

584

Elmore, M.R., and J.N. Hartley, Pacific Northwest Laboratory, Richland, WA

Evaluation of Field-Tested Fugitive Dust Control Techniques for Uranium Mill Tailings Piles

NUREG/CR-4089; 58 pp. (1985, January)

Potential wind erosion of uranium mill tailings is a concern for the surface disposal of tailings at uranium mills. Windblown tailings may subsequently be redeposited on areas outside the impoundment. Pacific Northwest Laboratory (PNL), under contract to the U.S. Nuclear Regulatory Commission, has investigated techniques for fugitive dust control at uranium mill tailings piles. Seventeen chemical stabilizers, rated as the most promising of those tested in earlier laboratory studies, were applied to test plots on a uranium tailings pile at the American Nuclear Corporation-Gas Hills Project mill site in central Wyoming. The durability of these materials when exposed to actual site conditions was evaluated over time. In addition, field testing of eight commercially available windscreens was conducted. Test panels of the eight different materials were constructed at the Wyoming test site to compare their relative durability to weathering. A second test was established near PNL to evaluate the effectiveness of three windscreens at reducing wind velocity, and thereby reduce the potential for wind erosion of uranium mill tailings. Results of the field tests of chemical stabilizers and windscreens are presented, along with observed effectiveness and durability versus cost information. Direct comparison of these two techniques is difficult due to the dependence of each on many site-specific factors. However, simplified model case studies were developed to assess the cost of chemical stabilization versus windscreen systems for a hypothetical, recently inactive tailings pile. (Auth)

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Elmore, M.R., and J.N. Hartley, Pacific Northwest Laboratory, Richland, WA

Evaluation of Chemical Stabilizers and Windscreens for Wind Erosion Control of Uranium Mill Tailings

PNL-SA-12382; 20 pp.; CONF-840859; Transfer and Utilization of Particulate Control Technology, Proceedings of the Fifth Symposium, Kansas City, MO, August 27, 1984 (1984, August)

Potential wind erosion of uranium mill tailings is a concern for the surface disposal of tailings at uranium mills. Wind-blown tailings may subsequently be redeposited on areas outside the impoundment. Pacific Northwest Laboratory (PNL) is investigating techniques for fugitive dust control at uranium mill tailings piles. Laboratory tests, including wind tunnel studies, were conducted to evaluate the relative effectiveness of 43 chemical stabilizers. Seventeen of the more promising stabilizers were applied to test plots on a uranium tailings pile at the American Nuclear Corporation-Gas Hills Project mill site in central Wyoming. The durabilities of these materials under actual site conditions were evaluated over time. In addition, field testing of commercially available windscreens was conducted. Test panels were constructed of eight different materials at the Wyoming test site to compare their durability. A second test site was established near PNL to evaluate the effectiveness of windscreens at reducing wind velocity, and thereby reduce the potential for wind erosion of mill tailings. Results of the laboratory and field tests of the chemical stabilizers and windscreens are presented, along with costs versus effectiveness of these techniques for control of wind erosion at mill tailings piles.

586

Flory, C., G. Gnugnoli, and S. Smykowski, U.S. Nuclear Regulatory Commission, Division of Waste Management, Washington, DC

NRC Review of UMTRA Radon Attenuation Cover Design

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985; 592 pp.; (pp. 3-12) (1985)

The U.S. Nuclear Regulatory Commission (NRC) evaluates the adequacy of radon attenuation cover design for Uranium Mill Tailings Remedial Action Program (UMTRAP) sites to determine if the cover would meet the Environmental Protection Agency's inactive site standards in 40 CFR Part 192. The U.S. Department of Energy (DOE) and NRC utilize the same basic mathematical model developed by Rogers & Associates Engineers. Because the model permits sufficient flexibility in choosing parameter values, NRC has had to establish some practical guidelines and minimal criteria in it's review of DOE parameter selection methods. This paper presents the essential ingredients of NRC's approach and an example of an NRC radon attenuation cover design review. (Auth)(DCM)

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Foley, M.G., W.J. Deutsch, G.W. Gee, J.N. Hartley, M.J. Fayer, R.W. Nelson, B.E. Opitz, R.J. Serne, and W.H. Walters, Pacific Northwest Laboratory, Richland, WA

Uranium Recovery Research Sponsored by the Nuclear Regulatory Commission at Pacific Northwest Laboratory: Quarterly Progress Report, July-September 1984

PNL-5015-4; 36 pp. (1984, November)

This report documents progress for four major research projects which are broken into nine discrete research tasks and a management task being conducted for the U.S. Nuclear Regulatory Commission (NRC), Office of Research, Waste Management Branch. The primary purpose of these tasks is to provide information to help the NRC license uranium recovery facilities. A truncated title of each research task follows: (1) Long-Term Stabilization, (2) Interim Stabilization of Mill Tailings Piles, (3) Tailings Dewatering Techniques, (4) Tailings Neutralization and Other Alternatives for Immobilizing Toxic Materials in Tailings, (5) Evaluation of Seepage and Leachate Transport From Tailings Disposal Facilities, (6) Effluent and Environmental Monitoring Methods and Equipment and Instrument Testing, (7) Attenuation of Radon Emmisions, (8) Assessment of Leachate Movement From Uranium Mill Tailings, and (9) Methods of Minimizing Ground Water Contamination From In Situ Leach Uranium Mining. (JWF)

588

Foley, M.G., W.J. Deutsch, J.N. Hartley, D.R. Kalkwarf, D.W. Mayer, R.W. Nelson, B.E. Opitz, S.R. Peterson, R.J. Serne, V.W. Thomas, W.H. Walters, and N.A. Wogman, Pacific Northwest Laboratory, Richland, WA

Uranium Recovery Research Sponsored by the Nuclear Regulatory Commission at Pacific Northwest Laboratory: Quarterly Progress Report, January-March 1983

PNL-4608-2; 57 pp. (1983, April)

Pacific Northwest Laboratory (PNL) is currently conducting research for the U.S. Nuclear Regulatory Commission (NRC) on process wastes both during the active and inactive life of uranium mills. The overall objective of this research is to provide NRC and their licensees with technical guidance on several issues related to management of wastes from uranium mills and in situ recovery operations. Principal issues addressed in these studies are: designs and performance of radon-suppression covers; the incentives, and constraints in using protective covers as well as their design for armoring tailings pile covers; shorter-term stabilization options for controlling windblown particles; leachate movement in soil; tailings dewatering; disposal deliberately below the water table; neutralization incentives; contamination control and restoration in in situ uranium recovery and effluent; and environmental measurements, instrumentation, and protocols. Many results of these studies will be used in developing regulatory guides and better evaluation of environmental impacts during and following the active life of a uranium recovery facility. (Auth)(RCF)

589

Foley, M.G., C.S. Kimball, D.A. Myers, and J.M. Doesburg, Pacific Northwest Laboratory, Richland, WA

The Selection and Testing of Rock for Armoring Uranium Tailings Impoundments

NUREG/CR-3747; PNL-5064; 113 pp. (1985, May)

Under contract from the U.S. Nuclear Regulatory Commission, Pacific Northwest Laboratory has developed an approach for selecting and testing rock for its suitability and durability as armor for protecting decommissioned uranium mill tailings piles. A preliminary survey of the literature determined that existing techniques for testing rock durability were inadequate for evaluating long-term (about 100 years) applications. Suites of rock samples with common lithologies and documented durations of exposure to weathering were then collected and submitted to three-axis ultrasonic testing in an attempt to develop a more reliable testing technique. Little correlation was found between the duration of weathering and ultrasound velocity or attenuation in the rock. Through further study, it was determined that the best screening approach incorporates common geomorphic field collection techniques and laboratory tests. Suites of samples with known durations of exposure to weathering can be subjected to wet abrasion and wetting-drying tests to screen local rock types and select those with the greatest potential durability. Furthermore, the expected decrease of rock mass with environmental stresses (e.g. flood impingement and diurnal wetting-drying cycles) can be estimated using this approach. (Auth)(JWF)

590

Hartley, J.N., M.G. Fluey, and G.W. Gee, Pacific Northwest Laboratory, Richland, WA

Uranium Mill Tailings Management: Cover Systems, Containment, Migration, and Long-Term Stability

AIME 84-50:14; CONF-840218; Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, Los Angeles, CA, February 26, 1984; (1984, February)

Uranium mill tailings, waste products of uranium extraction, contain hazardous constituents that if released into the atmosphere and groundwater could threaten human health and the environment. To provide for safe disposal and control of these tailings, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604). Subsequently, the U.S. Environmental Protection Agency (EPA) established standards for tailings disposal that limit radon emission into the air to 20 pCi/sq m/s on an annual average basis (EPA 1983). The design life of an impoundment is to be 1000 years where practicable, but 200 years at least. To facilitate the design of containment systems that will meet the EPA standards, the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE) are sponsoring research at the Pacific Northwest Laboratory (PNL) to develop the necessary technology. Earthen and asphalt materials have been evaluated for use as radon barriers and as liners to minimize leaching. Herbicide and rock barriers against biological intrusion have been evaluated. Surface stabilization techniques have been investigated to maintain the long-term effectiveness of a containment system that must be protected from wind and water erosion, chemical and physical degradation, and biological disturbance. This paper summarizes the research on uranium mill tailings management, including cover systems, liners, and long-term stabilization.

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Ibrahim, S.A., S.L. Church, and F.W. Whicker, Colorado State University, Department of Radiology and Radiation Biology, Fort Collins, CO; Yankee Atomic Electric Company, Farmingham, MA;

The Effects of Barium Chloride Treatment of Uranium Ore on Rn-222 Emanation and Ra-226 Leachability from Mill Tailings

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 327-334) (1985)

The purpose of this laboratory study was to investigate the effectiveness of barium chloride treatment of uranium ore on the control of radon-222 emanation from mill tailings, the radium-226 level in waste water, and the leachability of radium from tailings. It has been shown that barium sulfate is an excellent carrier for radium and

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that barium sulfate crystals have a high retention capacity for radon gas produced by radium trapped within the lattice. Ground uranium ore from a mine in Wyoming was mixed with water to form a 1:1 ratio before barium and potassium chlorides were added at concentrations of 0, 10, 25, 50, and 100 mg/l of slurry. The ore was then subjected to a simulated mill process using sulfuric acid leaching. The liquid representing tailings pond water was separated and analyzed for Ra-226. The solid fraction, representing mill tailings, was tested for radon emanation and the leachability of radium by deionized water. This study suggests that barium treatment of uranium ore prior to sulfuric acid leaching could be effective in reducing radon emanation from tailings and also in reducing the Ra-226 concentration of waste water. Leachability of radium from treated tailings was markedly reduced. (Auth)(DCM)

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Johnson, T.L., U.S. Nuclear Regulatory Commission, Division of Waste Management, Washington, DC

Design of Rock Covers for Reclaimed Uranium Mill Tailings Impoundments: A Regulatory Perspective

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 255-262) (1985)

Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978, provides the U.S. Department of Energy with authority to perform remedial actions at designated inactive uranium mill sites. The U.S. Environmental Protection Agency (EPA) promulgated radiological and nonradiological standards (40 CFR 192) for remedial actions at inactive uranium mill sites. All remedial actions require the concurrence of the U.S. Nuclear Regulatory Commission (NRC). The standards set forth in 40 CFR 192 require that remedial action designs provide reasonable assurance that tailings will be controlled for 1000 years (to the extent reasonably achievable) and, in any case, for at least 200 years. Implementation of this criteria requires the use of sound engineering practice combined with engineering judgment in many analytical areas. It has been the experience of the NRC staff that the design of a rock cover can be significantly affected by the selection of the design flood or design precipitation event. Preliminary reviews conducted by the NRC staff for various remedial action sites have indicated that a range of design assumptions and strategies are used in the determination of design basis floods and precipitation events for rock cover designs. The NRC staff has concluded that EPA criteria are met if the designs for erosion protection covers are based on the concepts of the Probable Maximum Flood (PMF) and the Probable Maximum Precipitation (PMP), and that EPA criteria may not be met by the use of statistically-derived flood estimates. In addition, dam failures need to be analyzed at those sites where upstream dams are not designed for a PMF. (Auth)

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Manca, P.P., G. Massacci, L. Massidda, and G. Rossi, Univ di Cagliari, Dipartimento di Ingegner Mineraria e

Stabilization of Mill Tailings for Mining Backfill with Portland Cement and Fly Ash

Institution of Mining and Metallurgy, Transactions, Section A 93:48-54 (1984, April)

An investigation has been carried out into the possibilities of the partial replacement of Portland cement with less expensive fly ash in cemented backfill that is prepared from mill tailings sands. The variables explored were the type of sand used as aggregate, curing times and the ratios of Portland cement to fly ash and water to binder. A correlation equation for the values of the moduli of elasticity and the corresponding unaxial compression strengths, which lends itself to useful predictions on the deformability of the backfill, was proposed. The conclusions were drawn from the experimental evidence that fly ash appears to be a technically attractive partial substitute for Portland cement and that mill tailings sands are suitable for the production of cemented backfill.

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Pacific Northwest Laboratory, Richland, WA

Uranium Recovery Research Sponsored by the Nuclear Regulatory Commission at Pacific Northwest Laboratory: Quarterly Progress Report, April-June 1984

PNL-5015-3; 35 pp. (1984, August)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT SITE STABILIZATION AND RECLAMATION

This report documents progress for four major research projects which include nine discrete research tasks and a management task being conducted for the U.S. Nuclear Regulatory Commission. The primary purpose of these tasks is to provide information to help the NRC license uranium recovery facilities. For the Long-Term Stabilization task, work continued on the case study analysis of riprap design methods for the Grand Junction and Slickrock tailings impoundments. Sensitivity analyses were performed on the Dolores River hydraulic data. The effects on the design stone size were evaluated. Initial test runs to evaluate the overland erosion model were completed. For the Interim Stabilization of Mill Tailings Piles, monitoring of the Wyoming field test site was completed. For the Tailings Dewatering Techniques task, the computer code designation was changed to TRUNC for Transient Unsaturated Consolidation. Predictions made using empirical methods of settlement analysis are compared with predictions using TRUNC for both saturated and partially saturated conditions. Based on TRUNC predictions, partially saturated settlement may prove to be the controlling factor in determining when to place a cover on tailings piles. For the Tailings Neutralization and Other Alternatives for Immobilizing Toxic Materials in Tailings task, all ongoing laboratory experiments were completed. Results of the contaminant/carbonate complexation studies and the tailings radium attenuation experiments are being compiled and will be documented in a laboratory progress report. For the Evaluation of Seepage and Leachate Transport from Tailings Disposal Facilities, the groundwater flow analysis and methodology for assessing leachate concentrations in the leachate seeping from uranium tailings disposed in deep mine stopes is finished. No work was performed for the Effluent and Environmental Monitoring Methods and Equipment and Instrument Testing task. A document describing the validation methods is nearing completion for the Attenuation of Radon Emissions. The Assessment of Leachate Movement from Uranium Mill Tailings is now funded by Low Level Waste. For the Methods of Minimizing Groundwater Contamination from In Situ Leach Uranium Mining, initial experiments to test the ability of sodium sulfide added to lixiviant to enhance aquifer restoration were completed. A geochemical model of natural aquifer restoration is being developed using the data from a column experiment in which Wyoming sediment was contacted with synthetic lixiviant. (Auth)

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Paschoa, A.S., J.A. Torrey, and M.E. Wrenn, University of Utah, Salt Lake City, UT

Radon Exhalation as a Function of Diffusion Lengths of Uranium Tailings Cover Materials

Transactions of the American Nuclear Society 46:61-62; CONF-840614; Proceedings of an American Nuclear Society Annual Meeting, New Orleans, LA, June 3-7, 1984; (pp. 61-62) (1984, June)

This paper shows the formulas used for a cost effectiveness analysis. The example problem used is the problem of reducing radon exhalation as a function of radon diffusion lengths of cover materials for uranium mill tailings. The cost effectiveness analysis can be used in this case either to determine the least expensive cover material to attain a preselected number of radon diffusion lengths, or to find the maximum reduction in radon exhalation that can be attained with a predetermined amount of money.

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Shepherd, T.A., C.W. Olenick, and R.E. Wardwell, Water, Waste and Land, Inc., Fort Collins, CO; Conquista Project, Falls City, TX

Development of Final Reclamation Plan for Uranium Tailings Impoundments

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 543-548) (1985)

Reclamation plans for uranium tailings impoundments have been developed and presented to both management and regulatory agencies as part of license applications and amendments. These plans have been generally developed in consideration of the current regulatory performance objectives, the limited technical information base available, and expected conditions at the end of operations. It is only recently that actual reclamation of the industries' tailings impoundments have been initiated. However, it is now realized that actual site conditions are different than originally anticipated and that regulatory expectations have changed. This has resulted in the necessity to reconsider the original reclamation plans and to develop new reclamation alternatives for actual implementation. As actual reclamation of the inactive and active industry uranium tailings sites proceeds, the state-of-the-art will be advanced. In addition, regulatory requirements will be better defined. However, as the initial reclamation projects are undertaken new ground is being broken and the time for implementation and testing of the theories put forward earlier has arrived. The purpose of this paper is to describe several aspects of the development of final reclamation plans which have been common for several projects recently undertaken. The development of final reclamation plans for other sites will require a similar process as the decision to reclaim occurs. The site conditions discussed include: (1) amount of tailings disposal capacity actually used in the impoundment; (2) distribution and nature of tailings; (3) surface water impounded; (4) existing environmental and stability conditions; and (5) cover and fill materials. (Auth)(DCM)

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Spehr, W., South Australian Health Commission, Adelaide, Australia

Effectiveness of Lead Smelter Slag in Suppressing the Release of Radon from a Uranium Tailings Dam

Radiation Protection in Australia 2(3):101-105; CONF-830823; Annual Conference of the Australian Radiation Protection Society, Adelaide, Australia, August 15-17, 1983 (1984, July)

The effectiveness of lead slag in suppressing the release of radon from uranium tailings was assessed and the factors on which radon suppression properties depend were investigated. Erratic short term variations in emanation rates from the pile surface complicated the assessment. The techniques, results and problems associated with the study are discussed.

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Throne, C.P., Coffey and Partners, Sydney, Australia

The Tailings Dam for the Ranger Uranium Project

CONF-8005177; CONF-8005194; Uranium Mine Waste Disposal, C.O. Brawner, (ed.), Proceedings of the First International Conference, Vancouver, British Columbia, Canada, May 19-21, 1980. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Society of Mining Engineers, New York, NY, 626 pp. (1980)

The ranger project is in the northern territory, Australia. The tailings dam is to be constructed in five stages, attaining a maximum height of 30 meters with a crest length of 4 kilometers. The planned storage is for 27 million tons of tailings and the construction will involve 6.2 million cu m of earth and rockfill. The project is sited in a tropical zone and the ground conditions show a laterized profile over weathered gneiss and schists. Narrow sections of pegmatite and amphibolite occur in the foundation and there are local areas of deeply weathered mica schist. Areas of the cutoff trench showing pegmatite intrusions or faulting were treated with sulfate resistant cement grout. The embankment has an upstream sloping clay core with a filter zone and supporting downstream rockfill. The materials come from the open pit spoil and from within the tailings dam. (Auth)(RHB)

599
U.S. Nuclear Regulatory Commission, Washington, DC

Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings - October 1980: Revision 1

REG/G-3.11.1 (1981)

This guide, a supplement to Regulatory Guide 3.11, describes in greater detail a basis acceptable to the NRC staff for developing an appropriate in-service inspection and surveillance program for earth- and rock-fill embankments used to retain uranium mill tailings.

600
Walters, W.H., and R.L. Skaggs, Pacific Northwest Laboratory, Richland, WA

Effects of Hydrologic Variables on Rock Riprap Design for Uranium Tailings Impoundments

NUREG/CR-3752; PNL-5069; 58 pp. (1985, January)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT SITE STABILIZATION AND RECLAMATION

Pacific Northwest Laboratory is studying the mitigation of erosion of earthen radon suppression covers for uranium tailings impoundments. Because the covers will require erosion protection for upwards of 1000 years, rock riprap (armoring) has been proposed as the primary protection method. This study investigates the sensitivity of riprap design procedures to extreme flood events that can generate high flow velocities and shear stresses. It evaluates the sensitivity of three riprap design methods to hydrologic variables derived from a range of flood discharges. The three methods are (1) Safety Factor Method, (2) Caltrans Method, and (3) Corps of Engineers Method. The purposes of the study are to determine how the variables affect the rock size required, identify any conservatism in design, and to evaluate the overall applicability of the methods to the tailings impoundment problem. The study uses two decommissioned tailings sites (Grand Junction and Slick Rock, Colorado) as case studies to evaluate the sensitivity of design rock size with respect to variables such as flood discharge, side slope, specific gravity, safety factor, and channel roughness. The study results indicate that the three design methods can yield significantly different rock sizes with the Corps of Engineers Method being the most conservative. Other results show that embankment side slope angles flatter than about 4H:1V are probably not necessary because the effect on rock size is negligible. For values of specific gravity less than about 2.50, the rock size required is very sensitive and, therefore, the use of low density rock may prove too costly. Also, using low values of channel roughness in the hydraulic calculations can significantly increase design rock size. (Auth)(JWF)

601

Ward, T.A., Mary Kathleen Uranium Limited, Melbourne, Australia

Rehabilitation Programme for the Mary Kathleen Uranium Mine

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 579-589) (1985)

The Mary Kathleen Uranium deposit, located in northwestern Queensland, Australia, was mined between the years 1958 and 1982. In October 1982 operations at the site ceased with the deposit virtually exhausted and all contractual commitments completed. Prior to the mine closure a detailed Rehabilitation Plan was developed and presented to the Queensland Department of Mines which is the regulatory authority for the State Government. The Department of Mines sought the views of other Government Departments having expertise or interest in specific areas, and the plan was subsequently approved. The plan was based on three basic principles of: making all areas safe for public access; removing all structures which could deteriorate and become unsightly or unsafe with time; and encouraging natural revegetation on erosion resistant surfaces. The aim was to leave the site in a safe and satisfactory condition, consistent with future land use in the area, requiring no foreseeable ongoing maintenance and a minimum of precautionary monitoring. When the program has been completed, the only constraint on future land use will be the need to control building construction in the tailings/evaporation, dumps and mine areas as a precaution against possible exposure to radon daughters. From the outset, a site-specific approach was adopted in developing the Plan. Experience at other sites was adopted only if it was appropriate for Mary Kathleen. As a result of this approach a conceptual solution was established for each area within the site. Each solution was then used as the basis for detailed planning for rehabilitation of that area. (Auth)(DCM)

602

Ward, T.A., J.C. Flannagan, and R.W. Hubery

Rehabilitation of the Mary Kathleen Uranium Mine Site After Closure

CONF-8309275; Water Regime in Relation to Milling, Mining and Waste Treatment Including Rehabilitation with Emphasis on Uranium Mining, Proceedings of an International Specialist Conference, Darwin, Australia, September 4, 1983 (1983)

The Mary Kathleen uranium mine and treatment plant ceased operation in late 1982, and a plan for the closure and rehabilitation of the area was developed. The object of the plan is to make all areas safe, remove all nonpermanent structures and encourage natural revegetation. The plan has been accepted by the Queensland Mines Department. The mine pit will be left stable, inaccessible to vehicles, and containing about 50 meters of water. Mine waste and borrow areas will be contoured, ripped and seeded to encourage revegetation. The treatment plant area will be cleared of all equipment and light structures, decontaminated and revegetated. The evaporation ponds will be dried out, precipitate and contaminated soil will be removed to the tailings dam, and the area will be contoured and revegetated. The tailings will be covered with one meter of waste rock and boreholes will be used to recover groundwater containing salts for storage in the pit.

603

Wardwell, R.E., and E.K. Donner, Water, Waste and Land, Inc., Fort Collins, CO

Water Management Aspects Relating to the Reclamation of Uranium Mill Tailings Impoundments

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 301-310) (1985)

Aspects relating to the constructibility of a reclamation plan include the dewatering of the surface pool, the excavation of the tailings, the drainage of the internal water, and placement of the fill and reclamation cover. The purpose of this paper is to describe the water management aspects of reclamation planning associated with the removal of the surficial pool and the evaluation of the need, if any, to remove internal water. (Auth)

604

Webb, J.W., and L.D. Voorhees, Oak Ridge National Laboratory, Environmental Science Division, Oak Ridge, TN

Revegetation of Uranium Mill Tailings Sites

Nuclear Safety 25(5):668-675 (1984)

Revegetation of soil-covered uranium mill tailings is one option for controlling and stabilizing tailings in a safe and environmentally sound manner. Two major effects of vegetation on soil-covered tailings are reviewed, and some of the techniques involved in successfully revegetating disturbed lands in the arid west, where most tailings disposal sites are located, are outlined. Vegetation plays an important role in reducing erosion and may also regulate soil moisture, thereby limiting dispersal of tailings and release of radionuclides. Successful revegetation of tailings depends on appropriate soil and plant species selection, optimal planting and cultural practices, provision of adequate moisture, and implementation of monitoring, at least initially. Major uncertainties associated with the use of revegetation programs include the potential for disruption of plant communities as a result of climatic change and natural catastrophes. Revegetation, in combination with other techniques, is an important component of stabilization plans for uranium mill tailings. (Auth)

605

Yamamoto, T., Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO

Review of Uranium Spoil and Mill Tailings Revegetation in the Western United States

FSGTR/RM-92; 27 pp. (1982, October)

The following aspects of uranium mine and mill tailings management are reviewed and discussed: (1) the history of the uranium remedial action program; (2) magnitude of the uranium spoils problem; (3) uranium deposits, mining, and milling; (4) status of reclamation; (5) problems in revegetation of uranium spoils and tailings; and (6) health and safety considerations.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT WASTE DISPOSAL

606

Case, G., D.B. Chambers, and J.B. Davis, Senes Consultants Limited, Willowdale, Ontario, Canada; Golder Associates, Mississauga, Ontario, Canada

Conceptual Design for the Disposal of Uranium Refinery Wastes in Mined Limestone Caverns

Health Physics 47(1):140; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

This paper describes the results of a conceptual study commissioned by Eldorado Resources Limited to assess the feasibility of geological disposal of uranium refinery wastes in mined caverns excavated in the limestone bedrock area. The study assessed excavation, handling and placement methods for the wastes and develops a practical cost-effective method of disposal of the approximately 400,000 cu m of wastes and contaminated soils. The concept incorporates a disposal scheme whereby the wastes are placed directly into 15 m wide, 50 m high and in excess of 100 m long caverns from the surface by means of vertical boreholes. The results of the study indicate that the concept is both technically feasible and practical using proven technology, with an estimated unit cost for the disposal of the low-level waste being on the order of $75 to $120 per cu m of material. (Auth)

607

Chambers, D.B., R.A. Knapp, and B.G. Ibbotson, Senes Consultants Limited, Willowdale, Ontario, Canada

Experience with Implementation of the ALARA Principle for the Decommissioning and Reclamation of a Uranium Mine/Mill Facility

Health Physics 47(1):139; CONF-840627; Proceedings of the 29th Annual Health Physics Society Meeting, New Orleans, LA, June 3-8, 1984 (1984, July)

In 1981, Eldorado Resources Limited announced that the Beaverlodge uranium mine/mill facility in northern Saskatchewan, which had been in operation since 1953, would be shut down in mid-1982. As a result, the development of an acceptable decommissioning and reclamation plan became a pressing and essential task. Several studies were undertaken as part of the development of such a plan, including the compilation of information about the local environment and the operating history of the facility, and the assessment of the engineering feasibility of possible disposal/reclamation options. The philosophy used to assess the reclamation options was founded on several principles including the ALARA principle. The aspects of ALARA and related concepts that influence their utility and application are discussed in the context of the Beaverlodge facility. Practical difficulties that arose, such as the identification of de minimis dose levels for individuals and the selection of limits of integration in space and time for population doses, are outlined. Finally, the results of the ALARA analyses that incorporated predicted dose reductions and costs for each reclamation option, are presented. (Auth)

608

Clausen, G., and J.F. Archibald, Queen's University, Department of Mining Engineering, Kingston, Ontario, Canada

Uranium Mill Tailings as Backfill in Underground Uranium Mines

Mining Science Technology 1(1):69-75 (1984)

A study of the effects of backfilling with classified uranium mill tailings in an underground mine was conducted during 1982 at Denison Mines Limited, Elliot Lake, Ontario. The principal objective of the study was to establish whether the introduction of this backfill material into working stopes would increase the background radiation in the mine atmosphere. The results of the study indicate that classified uranium mill tailings can be utilized as an effective backfill material without excessive control measures for radon and radon daughter concentrations. A summary of physical property and radiating parameter definitions are included at the end of the text to simplify terms set forth in this paper.

609

Hansen, L.A., R.E. Weeks, and R.K. Shrestha, Arizona State University, Department of Civil Engineering, Tempe, AZ

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT WASTE DISPOSAL

Evaluation of On-Site Soil for Use as an Impoundment Liner

ASTM Special Technical Publication 805:231-245 (1983)

The interaction of arsenic, chromium, manganese, molybdenum, and zinc with four clay soils was investigated by batch tests of pulverized soil specimens and column leaching tests on compacted specimens. These soils were being considered for construction of a liner for a proposed uranium tailings impoundment. Atterberg limits, metal concentrations, and x-ray diffraction analyses established two soil groups of similar composition. The batch and column tests established two soil groups with similar adsorption characteristics, but they included soils having different compositions. The testing established a tentative ranking of the relative sorptive capacities of the soils for the metals, though further testing is recommended.

610

Levins, D.M., and D.R. Davy, Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sutherland, Australia

Management of Wastes from Uranium Mining and Milling

IAEA-CN-43/147; STI/PUF 649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 3, 577 pp.; (pp. 141-168) (1984)

Waste management practices in uranium mining and milling are reviewed with an emphasis on recent trends that aim to reduce environmental impacts. Milling processes have not changed significantly in recent years although alternative non-polluting chemicals have been introduced in some mills. For amenable ore bodies, solution mining has emerged as an attractive alternative to conventional milling. No tailings are generated and there is minimal disturbance to the surface environment. Site-specific factors have more influence on waste management decisions than generalizations based on generic assessment. In semi-arid areas liquid wastes are best disposed of by evaporation. In areas where precipitation exceeds evaporation, discharge is mandatory after neutralization and barium chloride treatment to precipitate radium. Disposal of mill tailings is the most contentious issue facing the uranium industry. Modern tailings impoundments are designed to the same civil engineering standards as large earthen dams. Measures taken to minimize seepage loss include constructing a grout curtain, collecting seepage in toe drains, and sealing the inner surface of the impoundment with a clay or synthetic liner. Conventionally, tailings are discharged to the impoundment system as a dilute slurry but alternative methods of emplacement are attracting interest. These are: (1) sub-aerial deposition in which the tailings are emplaced as a succession of thin layers which are consolidated as they dry out; (2) thickened discharge in which a tailings slurry containing over 60% solids (by weight) is discharged from a central point to form a cone; and (3) dewatering on a belt filter, transport of the moist filter cake to the disposal site, and immediate consolidation by earth-moving equipment. These methods of emplacement result in higher tailings bulk densities and minimal seepage. Below-grade disposal is generally regarded as the best method of assuring long-term containment.

611

Martin, W.J., B.E. Opitz, and R.J. Serne, Pacific Northwest Laboratory, Richland, WA

The Effects of Column Dimensions on Uranium Mill Tailings Leach Curves

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 361-370) (1985)

To test the validity of using laboratory results to predict consequences of actual tailings disposal practices, leaching experiments were conducted using different sized columns filled with uranium mill tailings which were leached with laboratory-prepared groundwater. The data generated were used to evaluate the effects of length-to-diameter ratios on leach curves. The different column sizes and flow rates provided different solution/solid contact times (residence times) and different column volumes (scaling). The results showed that the leach curves were similar for all the columns, regardless of residence time or size, for all elements except chloride and calcium. The general shape of the leach curves for each constituent versus effluent volume was a rapidly decreasing curve from very high concentrations down to the groundwater concentration within about four to six pore volumes. Chloride elution was affected by mechanical dispersion, causing effluent concentrations to reach influent concentrations sooner for the columns with longer residence times. The calcium concentrations remained nearly constant or only slightly decreased over the duration of the experiments and were assumed to be controlled by the dissolution of gypsum. Aside from the chloride data, it was concluded that laboratory data obtained over the range of residence times and scaling factors studied can be used to predict long-term movement of contaminants from actual tailings impoundments. The main reactions that control contaminant leaching from tailings are the displacement of residual mill process liquor and the redissolution of readily soluble evaporites and moderately soluble gypsum. These processes occur quite rapidly; therefore, laboratory experiments with relatively short residence times are accurate. That is to say, lab residence times are long enough to transcend any short-term kinetic effects that could lead to erroneous predictions. (Auth)(DCM)

612

McKeon, T.J., and R.W. Nelson, Pacific Northwest Laboratory, Richland, WA

Evaluation Methods for the Consequences of Below Water Table Mine Disposal of Uranium Mill Tailings

NUREG/CR-3560; PNL-4904; 82 pp. (1984, January)

A method has been developed at the Pacific Northwest Laboratory to evaluate the environmental consequences of below water table disposal of uranium mill tailings in mine stopes. The method described uses analytical expressions for the velocity potential and examines the convective transport of tailings liquor and leachate through the aquifer and into a water supply well located downgradient from the mine stope. The arrival distribution of contaminant (mass flux versus time) and the concentration pumped from the well as a function of time are the final results of the analysis.

613

Mitchell, D.H., Pacific Northwest Laboratory, Richland, WA

Aging Geomembranes in Uranium Tailings Leachate

PNL-SA-11522; CONF-8406102; Geomembranes, Proceedings of the International Conference, Denver, CO, June 20, 1984 (1984)

Pacific Northwest Laboratory (PNL) is performing a study to provide the U.S. Nuclear Regulatory Commission (NRC) with a database to support licensing of uranium mill tailings ponds with geomembranes. As part of this study, geomembranes have been aged under conditions closely approximating those of uranium mill tailings ponds with acidic leachate. The aging procedure and results of tests with high density polyethylene (HDPE) and polyvinyl chloride (PVC) are presented. No degradation products were detected in the HDPE or the leachate. We expect that HDPE will not suffer significant chemical attack by uranium tailings and acidic leachate over the active life (20 years or less) of a pond. Because no large changes in physical properties were observed, we expect that changes in the physical properties of HDPE will be minor at mill tailings ponds with acidic leachate. Although testing is still underway, the PVC geomembrane has undergone some chemical reactions. Elongation declined as exposure temperatures increased, while other physical properties remained constant. The amount of aging simulated will be estimated when chemical analyses on PVC samples are completed.

614

Mitchell, D.H., Pacific Northwest Laboratory, Richland, WA

Technology for Uranium Mill Ponds Using Geomembranes

PNL-5164; NUREG/CR-3890; 86 pp. (1984, December)

Pacific Northwest Laboratory has analyzed the performance of polymeric membrane-lined impoundments containing tailings and leachate at active uranium mills. The U.S. Nuclear Regulatory Commission has requested this information to support licensing of impoundments. Data on the performance of lined ponds in the U.S. uranium industry, mechanisms for damage of liners, and design, installation, and inspection practices are presented in this report. Design, construction, and inspection methods that are capable of minimizing failures are also identified. No cases of contaminated groundwater are attributed to uranium mill ponds lined with polymeric membranes (geomembranes) in the U.S. The leading causes of geomembrane problems for all industrial pond applications are faulty seams, puncture and errors during placement, improper connections to submerged structures, puncture by soils in contact with the geomembrane, and geotechnical problems due to liquids in the support soil. Although some instances of liner problems with potential for significant consequences have been identified, the concensus of mill operators and regulatory personnel is that performance of ponds with geomembranes in the U.S. uranium industry has been satisfactory.

615

Mitchell, D.H., and G.E. Spanner, Pacific Northwest Laboratory, Richland, WA

Field Performance Assessment of Synthetic Liners for Uranium Tailings Ponds: Status Report

NUREG/CR-4023; PNL-5005; 78 pp. (1985, January)

The report presents the status, through the end of fiscal year 1983, of Pacific Northwest Laboratory's program of assessing the performance of synthetic liners used in uranium tailings ponds. Synthetic liner failure mechanisms, impoundment design, installation, and inspection techniques are presented from information collected from consultants, mill operators, and the synthetic liner industry. Progress is reported on laboratory tests on accelerated aging of liners, physical properties of aged materials, and nondestructive examination of seams. (Auth)(DCM)

616

Mueller, J.J., Controls for Environmental Pollution, Inc., Santa Fe, NM

New Process Encapsulates

Pollution Engineering 14( ):32-34 (1982, November)

The results of the various aspects of this study indicate that the encapsulation process is not only capable of reducing the percent of radon-222 emanation but also reduces the possibility of the leaching of toxic elements. Radon-222 emanation after solidification showed a 93.51% reduction from the slurry. The gamma spectral analyses of short-lived radon daughters supported the above findings. Leach studies on solidified refinery waste and transformer oils indicate there is a significant reduction in the possibility of toxic substances leaching out of the solidified samples. Further studies are needed to confirm the results of this investigation; however, the present findings indicate that the process could substantially reduce radon-222 exhalation into the environment from uranium tailings ponds and reduce toxic leachates from hazardous waste materials.

617

Opitz, B.E., and M.E. Dodson, Pacific Northwest Laboratory, Richland, WA

Treatment Scheme for Controlling the Migration of Radium from a Tailings Impoundment

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 451-460) (1985)

Under sponsorship of the U.S. Nuclear Regulatory Commission's Uranium Research and Recovery Program, Pacific Northwest Laboratory has investigated the use of various neutralizing reagents and techniques to attenuate the movement of contaminants associated with acidic uranium mill tailings. The objective of this study was to identify those contaminants which are not effectively attenuated by common neutralization methods and to develop alternative control measures. Of those contaminants associated with uranium mill tailings which were identified as not being effectively immobilized by tailings neutralization, radium imposes an important environmental concern in terms of potential groundwater contamination. Control or attenuation of radium is of special concern primarily due to its radiological health implications. For that reason, the U.S. Environmental Protection Agency (EPA) has implemented strict guidelines governing the maximum allowable concentration in drinking waters. Current EPA guidelines call for total radium activities not to exceed 5 pCi/l. Due to the high activity of soluble radium in the acidic uranium mill tailings environment (several hundred to several thousand pCi/l), specific ion removal procedures were investigated for use in attenuating radium in order to prevent future groundwater contamination. Results of these investigations led to the development of a tailings additive comprised of a mixture of hydrated lime and barium chloride, which, when added to acidic tailings, can reduce the amount of leachable radium escaping a designated tailings impoundment. In laboratory verification tests, this radium specific tailings treatment reduced the effluent solution activity of radium by three orders of magnitude, from greater than 3500 pCi/l to 1.7 pCi/l, in comparison with untreated acidic tailings. (Auth)

618

Osiensky, J.L., R.E. Williams, and W.P. Staub, University of Idaho, Moscow, ID; Oak Ridge National Laboratory, Oak Ridge, TN

Groundwater Pump-Back System for a Uranium Tailings Disposal Site

EPA/ET AI; Aquifer Restoration and Ground Water Monitoring, Proceedings of the Second Symposium, Columbus, OH, May 26-28, 1982; (pp. 30-38) (1982)

A brief overview of groundwater contamination from uranium mill waste disposal facilities is presented. Contamination control and remedial measures instituted at a uranium tailings pond in Wyoming are detailed. Hydrogeologic, hydrostratigraphic, and drilling studies revealed the extent of groundwater contamination. A groundwater pump-back system has been installed and is currently operating at the site to eliminate the surface seep and to dewater the paleochannel aquifer.

619

Poellot, J.H., D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA

Engineering, Environmental and Economic Planning for Tailings Disposal

CONF-820154; Geotechnics of Waste Management, Proceedings of the Society of Civil Engineers Conference, Philadelphia, PA, January 19, 1982 (1982)

There are two principal points made in this paper. First, mining waste materials, or tailings, are geotechnical materials. Their behavior follows the principles of soil mechanics and is predictable by these principles. Second, proper disposal, meaning safe, environmentally sound, and economical disposal, requires planning and recognizing waste disposal as part of the total mining system and process. In the development of these two principles, planning, design, and economic considerations of mine tailings are discussed.

620

Richardson, A.C.B., and W.D. Rowe, U.S. Environmental Protection Agency, Washington, DC

Optimization of Uranium Mill Tailings Disposal Practices

EUR-9173; 26 pp. (1984)

Releases of radioactivity from uranium tailings located in arid lands were studied. Alternatives were presented for the optimization of methods for quantitative disposal.

621

Robertson, A.M.G., Steffen, Robertson, and Kirsten, Inc., Vancouver, British Columbia, Canada

Site Selection and Design Options of Mining and Metallurgical Institutions

CONF-8205223; Proceedings of the 12th Council of Mining and Metallurgical Institutions Congress, Johannesburg, South Africa, May 3-7, 1982, Vol. 2; (pp. 861-865) (1982)

Intense public concern regarding the environmental and health effects of uranium tailings has forced a reevaluation of past disposal practices. This paper outlines the options that should be considered in selecting the site for, and the design of, the most economic and environmentally acceptable impoundment of tailings. A site selection method is described that ensures the consideration of all reasonable siting alternatives within a given radius of the plant site. Methods of qualitative and semi-quantitative evaluation of the alternative sites are mentioned that permit the sites to be rated according to visual, land-use, pollution-risk, and cost criteria. Alternative impoundment designs that are reviewed include embankments and diversions, liners, covers, and stabilization methods. Physical and chemical methods of tailings preparation that reduce the potential for pollution are considered briefly.

622
Schmitz, T.

Uranium Mine, Key Lake, Canada, As an Example of Final Deposition of Radioactive Tailings

Erzmetall 37(7-8):403 (1984, July-August)

The main part of the waste handling system treated in this study is tailings storage. The other parts include water storage reservoirs and monitoring ponds. Soil conditions and design features of the tailings pond are described in detail, as well as the method of tailings disposal. Finally, the method of deposition results in a laminated radioactive tailings deposit wherein the tailings reach a degree of compactness comparable to concrete. The Key Lake Mining Corporation and its consultants have developed a tailings handling program in order to minimize environmental impact and to take advantage of the natural topography and soil materials in the project area.

623
Shultz, D.W., Southwest Research Institute, San Antonio, TX

Field Studies of Geomembrane Installation Techniques, Technical Paper

PB-84-190586; 16 pp. (1984, May)

Fourteen construction sites where geomembranes were being installed were visited to observe subgrade preparation and liner installation techniques. These sites were visited during a study conducted for the U.S. EPA, Solid and Hazardous Waste Research Division. The sites included mine tailings disposal impoundments, landfills, potable water reservoirs, geothermal brine impoundments, evaporation impoundments, and industrial wastewater treatment impoundments. Six generic types of geomembrane materials were included in this study. They were (1) polyvinyl chloride (PVC), (2) high density polyethylene (HDPE), (3) chlorosulfonated polyethylene (CSPE), (4) chlorinated polyethylene (CPE), (5) Neoprene, and (6) ethylene propylene diene monomer (EPDM). Observed subgrade preparation procedures and geomembrane installation techniques are described in this paper.

624
Spanner, G.E., Pacific Northwest Laboratory, Richland, WA

Nondestructive Technique for Assessing Field Seam Quality of Prefabricated Geomembranes

PNL-SA-11527; CONF-8406102; Geomembranes, Proceedings of the International Conference, Denver, CO, June 20, 1984 (1984)

Research was conducted to test various nondestructive testing (NDT) methods that are or can be used to assess the quality of field seams in synthetic geomembranes. The objective of the work was to find a universally applicable technique and demonstrate its capabilities for field use on actual field seams. The research was conducted in two phases: laboratory investigations and a field demonstration. Sixteen different geomembane materials were considered with assorted seam defects including sand inclusions, gas bubbles, and masking tape spots. One technique, ultrasonic impedance plane analysis (UIP), was found to work on nearly all of the seams studied, including seams made from materials with woven scrim reinforcement. The UIP technique was demonstrated under simulated field conditions on a variety of materials. Conventional pulse-echo ultrasonic testing (UT) was found to be applicable to most of the nonreinforced materials.

625
Suichies (E.H.) and Associates; MIE Limited

Mine Tailings Disposal Options, Social and Economic Impact Analysis, Elliot Lake, Ontario

Report; 58 pp. (1983, April)

This report deals with tailings disposal in the Elliot Lake uranium mining area. Two basic disposal options, land-based and underwater disposal, are considered with emphasis on the social and economic implications of each. Underwater disposal of tailings appears to be less costly in the short term than continuation of the present land based disposal procedures. The actual longer-term costs of underwater disposal can be determined only by study of the impacts on the natural environment. The impact of underwater tailings disposal on radium-226 levels in the water environment may not be measurable until some time after deep lake disposal has started. A review of preliminary data suggests that underwater disposal will have an advantage over land-based disposal in that it minimizes pyrite oxidation and acid leaching. The reduction in production costs that may be achieved through implementing underwater disposal may increase the price competitiveness of Elliot Lake uranium on the world market and thereby stabilize employment opportunities. (Auth)(BDC)(NPK)

626

Umbarger, C.J., Los Alamos National Laboratory, Los Alamos, NM

TRU Waste Assay Instrumentation and Applications in Nuclear Facility Decommissioning

LA-UR-82-1062; CONF-821005; International Decommissioning Symposium - 1982, Proceedings of the U.S. Department of Energy's Remedial Action Program/OECD Nuclear Energy Agency Conference, Seattle, WA, October 10-14, 1982, 868 pp.; (pp. VI-10 - VI-27) (1982)

The Los Alamos TRU waste assay program is developing measurement techniques for TRU and other radioactive waste materials generated by the nuclear industry, including decommissioning programs. Systems are now being fielded for test and evaluation purposes at DOE TRU waste generators. The transfer of this technology to other facilities and the commercial instrumentation section is well in progress.

627

Wates, J.A., Partner, Jones and Wagenaar, Inc., Rivonia, South Africa

Disposal of Mine Tailings: The Real Cost of Excess Water in Residues

Journal of the South African Institute of Mining and Metallurgy 83(11-12):257-262 (1983, November-December)

The paper examines the consequences of dam building with slime of high water content, and therefore low relative density, such as the tailings usually associated with the extraction of uranium. It shows how a low relative density reduces the practical maximum rate of rise, and hence the establishment cost, of slimes dams built by conventional means. Further hidden costs of such tailings dams are examined. It is concluded that dewatering of tailings before their disposal is the most cost-effective means of increasing the rate at which a particular dam can be constructed, or of reducing operating or stability problems on existing dams. In the longer term, underground disposal seems to be a feasible alternative. However, it is pointed out that there are factors that can compound the operating difficulties, and that these should be investigated before remedial steps are taken.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT GENERAL STUDIES

628
Arnold, R.G.

Uranium Mine and Mill Tailings Management in Canada: Present Status and Future Directions

IAEA-CN-43/136; STI/PUB-649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 3, 577 pp.; (pp. 549-556) (1984)

Approximately 120 million tons of uranium mine and mill tailings have been accumulated to date in Canada. Uranium mines operating prior to the early 1960s used tailings management practices similar to those employed by other metal mines; that is, liquid and solid wastes were deposited in local topographic depressions or lakes without special treatment and were eventually abandoned. New emphasis on health and environmental quality in the 1970s resulted in concern about the management of uranium mine and mill wastes, which contain radionuclides, heavy metals, process reagents, and acid generated in tailings. Current practice for mine and mill waste management requires engineered containment structures for the storage of wastes. Liquid effluent from the primary containment facility is decanted into secondary ponds where it can be chemically treated. Addition of barium chloride to the effluents produces a radium/barium precipitate which settles out as a sludge. The liquid effluent is then re-used as process water or released into the environment when it meets water quality standards. Tailings are covered and vegetation planted for stabilization. Government and industry research and development programs are under way on abandoned, inactive and active tailings to determine the magnitude of environmental contamination, and to investigate the physical and biological pathways, rates of migration, and processes by which radioactive and chemical contaminants can be released from the tailings. Current trends in tailings management include deposition of thickened and filtered tailings, sub-aerial deposition, stacking of tailings to increase the capacity of tailings impoundments, deposition of tailings in mined-out pits, alternative uranium recovery methods to reduce process chemicals in effluent, and possibly deep lake disposal.

629
Radioactive Waste Processing in Uranium Mining Industry of Australia

Atomnaya Tekhnika za Rubezhom 10:29-31 (1983)

Experience in radioactive waste management in the uranium mining industry of Australia since 1954 is described. Rum-Jungle deposits which are associated with unsatisfactory results and others are considered. Particular attention is given to the radon protection problem.

630
Davis, J.B., V. Milligan, and J.L. Seychuk, Golder Associates, Toronto, Ontario, Canada

Review of International Uranium Mill Tailings Management Practice

CONF-8208145; Uranium '82, Proceedings of the 12th Annual Hydrometallurgical Meeting, Toronto, Canada, August 29-September 1, 1982 (1982)

Uranium tailings management practices adopted in various countries or, more specifically, uranium mining areas, tend to reflect several factors: the age of the mining and milling operation, the mining method (e.g. underground versus open pit), the ore grade, the regional geology, hydrogeology and geochemistry, the topography and geomorphology of the area, climatic conditions, and governmental regulations. Of these, only the last, governmental regulations, are by definition nationalistic in scope. However, even these tend to reflect the other factors which are imposed by nature. As a result of these factors, international mill tailings management strategies vary greatly and include both effluent and non-effluent producing systems, above and below grade disposal schemes, lined and unlined 'ponds' above and below water (both surface water and groundwater) emplacement, 'wet' and 'dry' methods of disposal, and pre-treatment of the gangue in the mill. This paper reviews current (and, where applicable, past) uranium mill tailings management practice(s) in Africa, Australia, Europe, and North America in the context of the above factors.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT
GENERAL STUDIES

631
Dory, A.B., Atomic Energy Control Board, Ottawa, Ontario, Canada

Uranium Mining - What Are the Issues?

INFO-0071 (Rev. 1); 10 pp. (1982, March)

The author discusses the effects of uranium mining on worker health and the environment, describes methods of handling mill tailings, and compares risks to the public from radiation with risks from non-nuclear energy sources. Information on nuclear issues in the news media is often sensationalistic; the public needs an open, honest information flow from industry, the scientific community, and government to reach a rational perception of the issues and risks.

632
Fry, R.M., Australian Academy of Science, Canberra, Australia

Management of Radioactive Wastes from Uranium Mining and Milling

INIS-mf-9434; CONF-8311218; Radioactive Waste Management: A Geoscientific Assessment Meeting, Canberra, Australia, November 30, 1983; (18 pp.) (1983, November)

Basic goals for the disposal of uranium mill tailings and criteria for judgement of the acceptability of waste management practices are presented. The discussion covers the nature of tailings and their radiological hazards, both local and remote, individual and collective, as well as health codes and engineering implications.

633
Hartley, J.N., and G.W. Gee, Pacific Northwest Laboratory, Richland, WA

Uranium Mill Tailings Remedial Action Technology

CONF-8406142; PNL-SA-12126; Hazardous Materials Management, Proceedings of a Conference, Philadelphia, PA, June 5, 1984 (1984)

The uranium milling process involves the hydrometallurgical extraction of uranium from ores and the resultant generation of large quantities of waste referred to as tailings. Uranium mill tailings have been identified as requiring remediation because they contain residual radioactive material that is not removed in the milling process. Potential radiation exposure can result from direct contact with the tailings, from radon gas emitted by the tailings, and from radioactive contamination of groundwater. As a result, the technology developed under the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action Project (UMTRAP) and the U.S. Nuclear Regulatory Commission (NRC) Uranium Recovery Program have focused on radon control, groundwater contamination, and the long-term protection of the containment system. This paper briefly summarizes the UMTRAP and NRC remedial action technology development.

634
International Atomic Energy Agency, Vienna, Austria

Management of Wastes from Uranium Mining and Milling

CONF-820552; STI/PUB-622; IAEA-SM-262; Management of Wastes from Uranium Mining and Milling, Proceedings of an IAEA and OECD/NEA International Symposium, Albuquerque, NM, May 10-14, 1982. International Atomic Energy Agency, Vienna, 745 pp. (1982, November)

The 45 papers published in these Proceedings were presented in seven sessions covering the following subjects: review of national programs, objectives and criteria for long-term management and disposal, concept evaluation for management and disposal, characterization of wastes, waste water treatment and tailings conditioning, decommissioning and rehabilitation technology development, radiological impact assessment, environmental surveillance and monitoring, radiation measurements, and national research and development programs. In addition, there is a summary of the panel discussion on the objectives, problems, and solutions for waste management in the uranium mining and milling industry.

635
Joe. E.G., Canada Centre for Mineral and Energy

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT GENERAL STUDIES

Technology, Department of Energy, Mines and Resources, Mineral Sciences Laboratories, Ottawa, Ontario, Canada

Research on Long-Term Management of Mine/Mill Tailings in Canada

CIM Bulletin 77(866):65; CONF-41.2; Proceedings of the 23rd Annual Metallurgists Conference, Quebec, Canada, August 19-22, 1984 (1984, June)

The mining industry in Canada has always been cognizant of the advantage of prudent tailings management to ensure protection of the surrounding mine environment and to meet the regulatory demands of government agencies. The long-term impact of final abandonment of waste tailings has been the subject of concern for mining and governmental research organizations over the past decade. More recently, major research program initiatives have been implemented for the uranium mines under the National Uranium Tailings Research program by CANMET, EMR. Preliminary investigations have also begun on the long-term management and abandonment of potash and acid-generating base metal mine/mill tailings. This paper presents an overview of the technical issues involved in the planning of the government-industry programs required to arrive at the most effective methods of containment. (Auth)

636

Joe, E.G., and P.A. Lapp, Lapp (Philip A.) Limited, Toronto, Ontario, Canada

Research Requirements for Long-Term Management of Uranium Mine Wastes

INIS-mf-7277; CONF-8106200; Proceedings of the 21st Annual International Canadian Nuclear Association Conference and the Second Annual Canadian Nuclear Society Conference, Ottawa, Canada, June 8-10, 1981; (p. 15) (1981, June)

At present there are more than 100 million tons of uranium tailings on the surface in Canada. While approximately one third of the tailings piles are inactive, most are under continual management. However, approximately 6 million tons are in abandoned tailings piles. In order to review present activities and plan a research program on the management of uranium mill waste, the National Technical Planning Group on Uranium Tailings Research was formed in 1980. This group proposed a research program consisting of three interactive parts: a modeling program, a national measurement program, and a disposal technologies program. It is expected that the national uranium tailings research program may require more than a decade for its completion. However, the proposed program covers an initial period of three years, at the end of which there should be a major review.

637

Lapp, P.A., National Technical Planning Group on Uranium Tailings Research, Ottawa, Ontario, Canada

Report of the National Technical Planning Group on Uranium Tailings Research

INIS-mf-9491; 176 pp. (1981, September)

The National Technical Planning Group on Uranium Tailings Research was formed in 1980 to review present activities and plan a research program on the management of wastes after a mine and mill have shut down. At present there are more than 100 million tons of uranium tailings on the surface in Canada. Most of these are under management; however, some 8 million tons have been abandoned completely. The group concluded that: (1) there has been no systematic attempt to collect and organize the results of measurements already made on tailings; (2) there is an inadequate understanding of the processes that take place in tailings and in the pathways to the biosphere; (3) there is insufficient evidence on the extent of the long-term problem in the closeout of a uranium tailings basin; (4) there is a need to establish standardized measurement methodologies to improve the quality of data taken at different sites across Canada; (5) generic research and development on tailings disposal technology should be within the scope of a national program, whereas site-specific work is the purview of the mines and regulatory agencies; and (6) the uranium producers' contribution to the national tailings program should be their research on site-specific disposal alternatives. The first of these conclusions leads to the proposal to establish a national uranium tailings research program. The second suggests the need for a modeling program, the third and fourth for a national measurement program, and the remaining conclusions refer to disposal technologies research. The conclusions form the basis for a set of recommendations on uranium tailings research.

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT GENERAL STUDIES

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Lawrence Berkeley Laboratory, Berkeley, CA

Special Projects

LBL-15500; Lawrence Berkeley Laboratory Earth Sciences Division Annual Report; (pp. 255-274) (1983, September)

Summaries are included of four special projects, each dealing with the problem of nuclear waste isolation. The issues addressed include high-level and low-level wastes. Site characterization strategies for nuclear waste disposal in basalt are presented. Field studies and laboratory investigations focus upon the problem of low-level radioactive waste disposal in relation to inactive uranium mill tailings at two sites, one in Wyoming and the other in Colorado. Thermomechanical investigations at Stripa, Sweden, reveal anomalous deviations in displacement measurements from predictions based on linear deformation theory. The role of fractures in this anomalous behavior is discussed. The advisability of considering the deep unsaturated zone at the Nevada Test Site as a possible candidate for high-level waste disposal is evaluated.

639

Levins, D.M., Australian Atomic Energy Commission Research Establishment, Lucas Heights, Sutherland, Australia

Environmental Impact of Uranium Mining and Milling in Australia

CIM Bulletin 73(822):119-125 (1980, October)

Australia has almost twenty per cent of the Western World's low-cost uranium reserves, located mostly in the Alligator Rivers region of the Northern Territory. At present, only one uranium mill is operating in Australia, but a number of new mills are planned for the early 1980s. Details are given of Australia uranium mining and milling proposals and the measures taken to minimize their environmental impact. Major factors affecting environmental impact are discussed, including treatment of liquid wastes, water management, control of radon and other airborne releases, and disposal of tailings.

640

Nelson, J.D., T.A. Shepherd, S.R. Abt, D. Van Zyl, and R.E. Wardwell, Colorado State University. Department of Civil Engineering, Geotechnical Engineering Program, Fort Collins, CO

Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp. (1985)

The first five annual Symposia on Uranium Mill Tailings Management focused on the design, construction, and operation of tailings impoundments. In recent years, problem areas regarding low-level waste and hazardous waste management have been identified as being candidates for direct application of technology developed for the uranium mill tailings management. Consequently, the Sixth Annual Symposium was of broader scope, and included low-level and hazardous waste management so as to increase the sphere of interest and provide a forum for the exchange of professional and technical experience in these interrelated areas. Over the past two years, as specific designs for the Uranium Mill Tailings Remedial Action Project have been completed, the uranium industry has begun reclamation of several tailings impoundments. For that reason, considerable attention was focused on the reclamation of waste disposal areas in the Seventh Symposium. One complete session was devoted to the current activities of the Uranium Mill Tailings Remedial Action Project (UMTRAP). Particular areas of interest addressed by the Seventh Symposium included regulations and public concerns; low-level waste; the UMTRAP; tailings and impoundments covers and long-term stability; hydraulic properties of tailings; contaminant migration, seepage and groundwater; and case histories. (Auth)(DCM)

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Nuclear Energy Agency, Organization for Economic Cooperation and Development, Paris, France

Uranium Mill Tailings Management

ISBN-92-64-02288-0; 237 pp. (1982)

CHAPTER 7. URANIUM MILL TAILINGS MANAGEMENT
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Facilities for the disposal of uranium mill tailings will invariably be subjected to geomorphological and climatological influences in the long-term. Proceedings of a workshop discuss how the principles of geomorphology can be applied to the siting, design, construction, decommissioning, and rehabilitation of disposal facilities in order to provide for long-term containment and stability of tailings. The characteristics of tailings and their behavior after disposal influence the potential impacts that might occur in the long-term. Proceedings of another workshop examine the technologies for uranium ore processing and tailings conditioning with a view to identifying improvements that could be made in such characteristics.

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Olivier, J.P., R.V. Osborne, and P.J. Rafferty, Nuclear Energy Agency, Organization for Economic Cooperation and Development, Paris, France; Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada

Long-Term Management of Uranium Mill Tailings: Results of the OECD/NEA Study

IAEA-CN-43/161; STI/PUB-649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 4, 423 pp.; (pp. 121-133) (1984)

The NEA study on the long-term aspects of the management of wastes from uranium mining and milling, which started in 1980, has covered radiation protection aspects, a review of technologies for uranium ore processing and tailings conditioning and disposal, engineering of disposal facilities for long-term stability, and post-operational surveillance and monitoring. The primary objective has been to examine the possibilities and difficulties of applying the ICRP system of dose limitation, in particular the principle of optimization of radiological protection, to the long-term management of uranium mill tailings. The paper gives an overview of radiological aspects of the study and describes briefly the methodology for cost-effectiveness analysis and its practical application to three hypothetical reference sites chosen to represent a broad range of management options in relatively different climatic conditions. It concentrates essentially on optimization and cost-effectiveness analysis. In particular it provides an initial discussion of conclusions that could be drawn from the study with regard to the choice among options, and the limitations of such analyses which arise mainly from uncertainties in environmental modelling of far-future situations.

643

U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, TN

Uranium Mill Tailings

DOE/TIC-3393 (Suppl. 1); 68 pp. (1985, March)

This bibliography contains information on uranium mill tailings included in the U.S. Department of Energy's Energy Data Base from November 1982 through December 1983. The abstracts are grouped by subject category. Entries in the subject index also facilitate access by subject. Within each category the arrangement is by report number for reports, followed by nonreports in reverse chronological order. These citations are to research reports, journal reports, journal articles, books, patents, theses, and conference papers from worldwide sources. Five indexes, each preceded by a brief description, are provided: Corporate Author, Personal Author, Subject, Contract Number, and Report Number. (Auth)(CAC)

644

Introduction to Uranium Mill Tailings Isolation and Containment

Uranium Institute, London, United Kingdom; 38 pp. (1984, May)

The subject is discussed under the headings: (1) introduction (historical need for adequate arrangements to protect human health and natural environment); (2) characteristics of uranium mill tailings (separation of uranium from other constituents in the ore in a mill, heap leaching or in-situ leaching, leaving radioactive wastes); (3) objectives of tailings management (aimed particularly at limiting the release of the radionuclides); (4) nature of risks, either from direct exposure or through the food chain; (5) general techniques of tailings management (methods of physical containment); (6) site specific considerations (pathways by which harmful constituents might reach potential receptor populations); and (7) the sequence of containment and management.

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Walker, D.G., R.M. Fry, and I.W. Morison, Office of the Supervising Scientist for the Alligator Rivers Region, Sydney, Australia; Australian Atomic Energy Commission, Sydney, Australia; Department of National Development and Energy, Canberra, Australia

Waste Management and Environmental Controls in the Australian Uranium Mining Industry

IAEA-CN-42/452; STI/PUB-627; CONF-820914; Nuclear Power Experience, Volume 3 - Nuclear Fuel Cycle, Proceedings of an International Conference, Vienna, Austria, September 13-17, 1982. International Atomic Energy Agency, Vienna, 910 pp.; (pp. 289-308) (1983)

The development of waste management and related environmental controls currently applied to uranium mining and processing in Australia is described. The Ranger Uranium Environmental Inquiry of the mid-1970's was a focus for the expression of public concerns over the environmental effects of uranium mining. The report of inquiry established a framework for control over uranium mining in the Northern Territory and, by association, other states of the commonwealth. The interaction between federal and state jurisdictions and the establishment of codes of practice and their implications are briefly described. Current procedures are based on the experience of other countries but are much influenced by studies of the environmental impact of uranium production in Australia during the 1950s and 1960s. In addition, laboratory investigations have been made of specific processes, such as the impact of heavy metal contaminations on biota and the uptake of radium in the human food cycle. Such studies are continuing and research is being expanded, particularly in relation to Northern Territory developments. (Auth)

Chapter 7

URANIUM MILL TAILINGS MANAGEMENT

- Design, Planning, and Regulations
- Environmental Studies and Site Surveys
- Health, Safety, and Biomedical Studies
- Decontamination Studies
- Site Stabilization and Reclamation
- Waste Disposal
- General Studies

CHAPTER 8. TECHNICAL MEASUREMENTS CENTER

646
Duray, J.R., Bendix Field Engineering Corporation, Grand Junction, CO

The Remedial Action Program's Technical Measurements Center - Status

CONF-830205; Waste Management '83, Proceedings of a Conference, Tucson, AZ, February 27-March 3, 1983, Vol. 1; (pp. 169-176) (1983)

The Bendix Field Engineering Corporation's Technical Measurement Center (TMC) in Grand Junction, Colorado was established to support the remedial actions program of the U.S. Department of Energy. TMC has undertaken several tasks related to field and laboratory radiation measurements. Progress on establishing calibration facilities and procedures for surface and subsurface gamma-ray measurements as well as radon daughter and radon flux measurements is described. Protocols for these measurements are being developed.

647
Duray, J.R., and M.G. White, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO; U.S. Department of Energy, Division of Remedial Action Projects, Washington, DC

Review of Selected DOE Remedial Action Field Measurement Procedures for the Summer of 1982

GJ/TMC-02; 75 pp. (1982, August)

The objective of this study was to review the existing radiation measurement procedures used in the Formerly Utilized Sites Remedial Action Program (FUSRAP), Grand Junction Remedial Action Program (GJRAP), and the Uranium Mill Tailings Remedial Action Program (UMTRAP). Each of these programs has environmental measurement requirements, some similar in scope and method to those in other programs, some unique to a program. In response to the need for standardization, calibration, comparability, verification of data, quality assurance, and cost effectiveness, the Technical Measurements Center (TMC) has reviewed existing methodologies for radiation measurements. Procedures reviewed include: subsurface radium measurements, radon and radon daughter measurements, sample gathering and preparation, and surface radiometrics. Few procedures exist for subsurface radium measurements (borehole logging) and even fewer have been documented. The radon and radon daughter measurement protocols to be used at remedial action sites during FY 1982 were reviewed. The planned measurements include: radon concentration, working level, air particulates, and radon flux. Procedures for the collection and preparation of soil and water samples were reviewed with respect to the following parameters: hydrology, soil sample plan design, water sample collection and preservation, and field chemical analyses. (PTO)

648
Engelder, P.R., S. Donivan, and R.B. Chessmore, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO; U.S. Department of Energy, Grand Junction Area Office, Grand Junction, CO

Development of Solid Thorium Reference Materials

GJ/TMC-22; 33 pp. (1985, May)

Bendix Field Engineering Corporation, as an operating contractor for the DOE Technical Measurements Center, has prepared solid thorium-232 reference material for use by remedial action contractors and cognizant federal and state agencies. Three concentrations of material were prepared, targeted at 70, 30, and 10 pCi/g, by diluting thorium ore with river bottom soil. All materials were dried and blended thoroughly to ensure homogeneity. Several statistical tests were performed on the analytical data to characterize the reference materials. The recommended thorium-232 concentrations for the three reference materials are 71.2, plus or minus 2.0 pCi/g; 30.5, plus or minus 0.6 pCi/g; and 10.2, plus or minus 0.3 pCi/g. Use of these reference materials will aid in providing uniform standardization among measurements made by remedial action contractors. (JWF)

649
Fleischhauer, H.L., and P.R. Engelder, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO

Procedures for Reconnaissance Stream-Sediment Sampling

CHAPTER 8. TECHNICAL MEASUREMENTS CENTER

GJ/TMC-14; 20 pp. (1985, February)

This document recommends a simple grab-sampling procedure for reconnaissance-scale sampling conducted to detect the presence of radioactive pollutants in streams. This procedure is based on methods used in the National Uranium Resource Evaluation, a program of the U.S. Department of Energy, Grand Junction Projects Office. For studies of the vertical distribution of radioactivity in stream sediments, a rapid, shallow coring procedure using PVC pipe is described. In addition to the recommended sampling procedures, a number of factors that may influence the results of a stream-sediment survey are briefly discussed. These factors include particle size, temporal variation and composition of samples. (Auth) (CAC)

650

Key, B.N., Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO

Test and Evaluation of Selected Instruments for Surface Gamma-Ray Measurements

GJ/TMC-16; 165 pp. (1984, August)

This report presents the results of a study conducted to test and evaluate selected instruments to determine their applicability and effectiveness for use in making surface gamma-ray measurements. Design characteristics that affect performance in remedial action applications are examined. Also presented are the results of tests conducted to assess several aspects of instrument performance, including counting-plateau quality, sensitivity, dead time, linearity, sensitivity to high ambient radiation, counting sensitivity, and spectral response. In general, the instruments performed satisfactorily; exceptions are discussed and, where apparent, the probable cause of unsatisfactory performance is suggested. Recommendations are made with respect to design and performance characteristics to aid in the selection of instrumentation for use in remedial action work. (Auth)

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Korte, N., M. Hollenbach, and S. Donivan, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO

Laboratory Intercomparison of Analytical Results on Samples Contaminated by Uranium Mill Tailings

GJ/TMC-19; 110 pp. (1984, October)

This laboratory intercomparison study was conducted to assess the adequacy of state-of-the-art techniques used to analyze samples collected at DOE remedial action sites. Resources available for the study were directed toward quickly obtaining the maximum amount of pertinent data without performing an extensive statistical analysis. Hence, the methods evaluated are primarily applicable to analysis of samples contaminated with uranium mill tailings, since samples of that type were readily available. The analytical methods and calibration techniques used are discussed in this report, as are the results of the intercomparison study. Information presented should be helpful in the selection of a support laboratory and in planning for and ensuring reliable laboratory analysis. (Auth)

652

Langner, G.H., Jr., and T. Nelson, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO

Operating Manual for the Radon-Daughter Chamber

GJ/TMC-18; 100 pp. (1985, January)

A radon-daughter chamber was constructed at the U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) facility for the purpose of calibration, testing, and evaluating radon and radon-daughter measuring instruments used in support of DOE remedial action programs. The chamber is an environmentally controlled cylindrical vessel through which air containing radon can be circulated. Environmental parameters within the chamber and their respective controllable ranges include radon concentration (1 to 100 pCi/l), ventilation rate (0.25 to 10 air changes per hour), temperature (0 deg to 45 deg C), dew point (-10 deg C to saturated), and condensation-nuclei concentration [10 to 10(E+6) cu cm]. Environmentally conditioned air containing radon gas is circulated through the chamber by two blowers, one pushing air into the chamber from the bottom and the other pulling air from the top of the chamber. Pressure inside the chamber is controlled such that it is near that outside the chamber. The air that flows through the chamber may be either recirculated or exhausted after a single pass-through. Temperature in the chamber is controlled by circulating a hot or cold solution of ethylene glycol and water through the copper tubing covering the outside of the chamber's stainless-steel shell. This document describes the mechanical equipment, the start-up, operating, and shut-down procedures, maintenance requirements, and an analysis of the built in safety features. (Auth)(CAC)

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Myrick, T.E., M.S. Blair, R.W. Doane, E.T. Loy, and W.H. Shinpaugh, Oak Ridge National Laboratory, Oak Ridge, TN

An Updated System for Mobile Gamma-Ray Scanning

Health Physics 43(1):156; CONF-830695; Proceedings of the 28th Annual Health Physics Society Meeting, Baltimore, MD, June 19-24, 1983. Pergamon Press, New York, NY (1983, June)

The mobile gamma-ray scanning system developed and operated for the Department of Energy by Oak Ridge National Laboratory (ORNL) has been upgraded to improve sensitivity and reliability and to provide continuous radionuclide-specific analyses. The gamma-ray detection system consists of three 4- X 4- X 16-in. NaI(TI) Polyscin log crystals, each with an integral 3.5-in. Photomultiplier tube. The crystals are housed in a lead-shielded steel frame to provide a 12- X 16-in. Detector surface area for acceptance of gamma rays through one side of the survey van. The detector and shield height can be varied with a hydraulic lift mechanism to optimize the detector field of view. The detector output is transferred to a computer-controlled eight-channel discriminator and interface, designed and fabricated at ORNL. This unit provides for continuous analysis of data inputs for correlation of system location with count rate information. Six separate energy regions-of-interest are analyzed, and a radium-226-specific algorithm is employed to identify locations containing residual radium-bearing materials. Data on other naturally occurring radionuclides are obtained for comparison as part of the analysis. Multi-channel analysis capabilities are included in the system for additional qualitative radionuclide identification. The system is operator controlled through keyboard instructions to an on-board minicomputer. Data output is provided on the computer video screen, dual stripchart recorders, and a graphic printer. Data storage is provided by a dual floppy disc system. (Auth)

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Showalter, R.A., and L. Johnson, Bendix Field Engineering Corporation, Technical Measurements Center, Grand Junction, CO

Radon-Daughter Chamber Instrumentation System: Reference Manual

GJ/TMC-20; 309 pp. (1985, January)

The radon-daughter chamber instrumentation system collects environmental data from the radon-daughter chamber. These data are then recorded on a Tandberg system tape cartridge and transmitted to the HP-1000 computer for processing. Generators which inject radon and condensation nuclei into the chamber are also included with the instrumentation system.

655

Stieff, L.R., Stieff Research and Development Company, Inc., Kensington, MD

Feasibility Study of the Prompt Pb-214, Bi-214 Gamma Method for Determining Radon Migration Through Tailings

GJ/TMC-05; 36 pp. (1983, September)

A study has been performed to determine the feasibility of using the prompt Pb-214/Bi-214 gamma method to determine the presence of unsupported Rn-222 in a freshly collected tailings sample and the undisturbed state of secular equilibrium between Ra-226 and Rn-222 at the time of sample collection. Tailings pile core samples were collected from four layers of the sandbox, a special test area within the Grand Junction tailings pile. They were immediately placed in aluminum cans. Gamma measurements were then made to follow the prompt decay and subsequent buildup of Pb-214/Bi-214. By observing the difference, either positive or negative, between the gamma count rate extrapolated to the time of sample collection and the equilibrium count rate, a measure of the net loss or gain of Rn-222 that occurred in the sample during the 2 to 3 hours that preceded sample collection was obtained. Using this technique, it was found that some samples contained a net excess of Rn-222, some contained a net deficiency, and one sample contained Rn-222 and Ra-226 in secular equilibrium. (Auth)(PTO)

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Stieff, L.R., Stieff Research and Development Company, Inc., Kensington, MD

A Feasibility Study of the Use of Nuclear-Emulsion Techniques in the Study of Drill Core and Water Samples from the Monticello Mill, Monticello, Utah

GJ/TMC-15; 114 pp. (1984, April)

This nuclear-emulsion feasibility study of the Monticello drill-core and water samples suggests that nuclear-emulsion techniques can provide a unique way of directly observing the modes of occurrence of and the relative mobility of some of the different alpha-active radionuclides in the uranium and thorium decay chains. The qualitative, descriptive information on the localization of these radionuclides, even though in this study the identification of associated minerals could be only tentative at best, suggests that subsequent nuclear-emulsion studies combined with detailed mineralogic studies should be able to contribute in several important ways to the uranium mill tailings remedial action program. These contributions include: (1) characterizing tailings piles on the basis of the modes of occurrence of uranium, radium, radon, and other radionuclides, their mineralogy, and their relative mobility; (2) proposing specific remedial action based on the modes of occurrence of Ra-226 and Th-230; (3) providing new techniques for assessing both the short-term and long-term effectiveness of certain remedial actions; (4) procedures for minimizing the further movements of Ra-226 and Rn-222 within the tailings pile; (5) providing a new technique for detecting very low concentrations of Rn-222, Ra-226, Th-228, and certain other radionuclides in water samples; and (6) providing a means of identifying those tailings piles which may present special health hazards because they contain numerous, intensely alpha-active, Ra-226-bearing particles in the colloidal to submicron size range. (Auth)

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White, G., and J.R. Duray, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM; Bendix Field Engineering Corporation, Grand Junction, CO

The Technical Measurements Center Role in the DOE Remedial Action Program

CONF-841105; Nuclear Power - A Global Reality. Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (pp. 52-53); Transactions of the American Nuclear Society 47:52-53 (1984)

The primary objectives of the Technical Measurements Center are to assure quality measurements and consistency throughout DOE remedial action programs and to respond to project -pecific problems. Foremost among the many activities s the establishment of calibration facilities and associate procedures, the establishment of standard field and laboratory measurement procedures, and the conduct of comparative evaluations of measurement devices and methods. (Auth)

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White, M.G., U.S. Department of Energy, Washington, DC

Remediation of Contaminated Sites Resulting from Ore Extraction and Refining

CONF-840229; Shaping our Energy Future, Proceedings of the 11th Annual WATTec Conference and Exposition, Knoxville, TN, February 21, 1984; (p. 60) (1984)

The Technical Measurements Center of the U.S. Department of Energy's Remedial Action Projects was established in 1982 to bring about a consolidated approach to various measurement programs. The applications of these activities to remedial action programs are multiple and assure the quality of the actions taken to decontaminate and release or manage specific sites. One factor is paramount in the environmental measurements performed to support remedial action activities. That is the calibration of measurement systems. These measurements determine the need and the extent of remedial actions at these sites and therefore greatly

affect expenditure of taxpayer monies. No two contractors calibrate instrumentation using the same techniques, similar physical standards, or duplicate controls. It becomes very important for the DOE to fund programs to formally document investigation, evaluation, and recommendations of measurement methods. In this way the most reliable methods can be documented and are then available for use at a variety of mill tailings and extraction process plants. Other factors are also important to the establishment of a high quality measurements program in order to assist in decision-making for guidance in design and implementation of remedial actions. These include clear definition of decontamination and release standards, and clear integration of all program elements from investigation through remediation since these elements are performed by a sequence of contractors.

659

White, M.G., U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

Technical Measurements in DOE Remedial Actions Activities

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The purpose of the Technical Measurements Center (TMC) is to provide calibration facilities, develop and review standard measurement procedures and techniques for the various DOE projects. TMC also develops and provides guidance for the use of physical standards in field and laboratory measurements and analytical systems, evaluates instrumentation and analytical systems available for programmatic field and laboratory uses, and provides special problem-solving expertise and support services where needed. TMC is chartered to address specific individual programmatic needs as well as broad across-the-programs needs for quality, valid measurements.

Chapter 8

TECHNICAL MEASUREMENTS CENTER

CHAPTER 9. GENERAL REMEDIAL ACTION PROGRAM STUDIES

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Ausmus, B.S., and M.F. Tardiff, Bechtel National, Inc., Oak Ridge, TN

Environmental Implications of Decontamination and Decommissioning Nuclear Facilities

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 42-43); Transactions of the American Nuclear Society 45:42-43 (1983)

A component of each phase of the nuclear fuel cycle are wastes that must be managed. The authors present the major components of the fuel cycle and relative environmental implications of decontamination operations and, ultimately, the decommissioning of these facilities. Surplus facilities and formerly utilized sites were included because they represent a historical commitment of resources and an inventory of contaminated facilities which must be dealt with in order to return land facilities to productive or economically viable applications.

661

Baublitz, J.E., U.S. Department of Energy, Division of Remedial Action Projects, Washington, DC

Federal Government Cleanup Program

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The federal program for low-level nuclear waste is a composite of several programs under the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, and the U.S. Department of Energy. NRC and EPA have broad jurisdiction with major emphasis on regulatory activities. DOE programs are non-regulatory and are specifically related to past and present agency activities or to legislation specifically mandating cleanup activities. This paper outlines the various programs within these agencies and cites the legislation under which each activity is mandated. (ARE)

662

Bernhardt, D.E., M.W. Grant, D.C. Rich, C.M. Jensen, and P.J. MacBeth, Rogers and Associates Engineering Corporation, Salt Lake City, UT

Radioactive Contamination at Nuclear Fuel Cycle Facilities: Final Report

PB-83-176610; 231 pp. (1982)

This report presents information to characterize uranium fuel cycle facilities (excluding reactors), levels of contamination at those facilities, and volumes and activity of wastes associated with their decontamination and decommissioning (D&D). It is one of a series of reports providing information to assist the U.S. Environmental Protection Agency in setting standards and guidelines for permissible residual levels of radioactivity from D&D. The categories of facilities covered by this report are: uranium mines; uranium mills; uranium hexafluoride conversion plants; and fuel fabrication plants, including both low- and high-enriched uranium and mixed-oxide facilities. Both active and inactive facilities are identified. The highest volumes of D&D waste (hundreds of millions of cu m) are associated with uranium mines, while the highest amounts of radioactivity are a result of D&D at fuel reprocessing plants.

663

Low-Level Nuclear Waste Cleanup

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

The federal program for low-level nuclear waste cleanup is a composite of several programs under the jurisdiction of the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, and the U.S. Department of Energy. The NRC and EPA have broad jurisdiction with major emphasis on regulatory activities. DOE programs are non-regulatory and are specifically related to past and present agency activities or to legislation specifically mandating cleanup activities. Panel discussions and papers presented information about the federal cleanup program, lessons learned based on actual case histories, community relations planning, health effects data, the DOE measurements program, low-level waste disposal facilities, and liability considerations. (ARE)

CHAPTER 9. GENERAL REMEDIAL ACTION PROGRAM STUDIES

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Denham, D.H., R.D. Stenner, C.G. Welty, Jr., and T.S. Needels, Pacific Northwest Laboratory, Richland, WA; U.S. Department of Energy, Office of Policy. Safety and Environment, Washington, DC

DOE's Assurance Program for Remedial Action (APRA)

PNL-SA-12443; CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 6) (1984)

The U.S. Department of Energy's (DOE) Office of Operational Safety (OOS) is presently developing and implementing the Assurance Program for Remedial Action (APRA) to overview DOE's Remedial Action programs. APRA's objective is to ensure the adequacy of environmental, safety and health (ES and H) protection practices within the four DOE Remedial Action programs: Grand Junction Remedial Action Program (GJRAP), Uranium Mill Tailings Remedial Action Program (UMTRAP), Formerly Utilized Sites Remedial Action Program (FUSRAP), and Surplus Facilities Management Program (SFMP). APRA encompasses all ES and H practices of DOE and its contractors/subcontractors within the four Remedial Action programs. Specific activities of APRA include document reviews, selected site visits, and program office appraisals. Technical support and assistance to OOS is being provided by APRA contractors in the evaluation of radiological standards and criteria, quality assurance measures, radiation measurements, and risk assessment practices. This paper provides an overview of these activities and discusses progress to date, including the roles of OOS and the respective contractors. The contractors involved in providing technical support and assistance to OOS are Aerospace Corporation, Oak Ridge Associated Universities, and Pacific Northwest Laboratory.

665
Forsberg, C.W., Oak Ridge National Laboratory, Oak Ridge, TN

Flowsheets and Source Terms for Radioactive Waste Projections

ORNL/TM-8462; 141 pp. (1985, March)

Flowsheets and source terms used to generate radioactive waste projections in the Integrated Data Base (IDB) Program are given. Volumes of each waste type generated per unit product throughput have been determined for the following facilities: uranium mining, UF6 conversion, uranium enrichment, fuel fabrication, boiling-water reactors (BWRs), pressurized-water reactors (PWRs), and fuel reprocessing. Source terms for DOE/defense wastes have been developed. Expected wastes from typical decommissioning operations for each facility type have been determined. All wastes are also characterized by isotopic composition at the time of generation and by general chemical composition.

666
Kennedy, W.E., Jr., R.R. Kinnison, R.O. Gilber, and E.C. Watson, Pacific Northwest Laboratory, Richland, WA

Statistical Aspects of Determining Compliance with Radiation Standards

CONF-800731; Proceedings of the Health Physics Society Meeting, Seattle, WA, July 20-26, 1980 (1980)

Radiation surveys are an important tool used to monitor the safety of operations at nuclear fuel cycle facilities, as well as determining if contaminated sites require remedial action before license termination or unrestricted release. It is important that radiation surveys be carefully designed to provide the right quantity and quality of useful information for making valid decisions concerning public safety. The validity of survey information is especially important when low-level radiation detection techniques are required, such as for environmental radiation monitoring. Thus, statistical aspects of radiation surveys are important in demonstrating compliance with radiation guidelines and for deciding when remedial action or cleanup is required. The statistical aspects of evaluating whether guidelines are being exceeded is discussed.

667
Leggett, R.W., H.W. Dickson, and F.F. Haywood, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

A Statistical Methodology for Radiological Surveying

CHAPTER 9. GENERAL REMEDIAL ACTION PROGRAM STUDIES

IAEA-SM-229/103; CONF-780612; Advances in Radiation Protection Monitoring, Proceedings of a Conference, Stockholm, Sweden, June 26-30, 1978. International Atomic Energy Agency, Vienna; (pp. 541-554) (1979)

The Oak Ridge National Laboratory has conducted radiological surveys of several installations used in the early days of the United States' atomic energy program. The need for an efficient, thorough, statistically sound approach for characterizing and documenting the radiological status of buildings and undeveloped land areas was apparent. As a result, an improved statistical methodology for conducting radiological surveys has been developed. The Central Limit Theorem of statistics has been used to suggest methods for estimating the mean values of radiological conditions such as alpha contamination levels, beta-gamma surface dose rates and external gamma radiation levels. Guidance is provided in determining the sufficiency of sample size, choosing the number of survey-meter measurements, measuring the variability of radiological conditions, and comparing measured values with existing radiation safety guidelines at a prescribed level of confidence. Examples of the application of the methodology to actual radiological surveys are given. (Auth)

668

Miller, M.G., and S.R. Miller, U.S. Department of Energy, Washington, DC

Perspectives and Issues in DOE Remedial Action Programs

CONF-831047; Proceedings of an American Nuclear Society Winter Meeting, San Francisco, CA, October 30-November 4, 1983; (pp. 45-46); Transactions of the American Nuclear Society 45:45-46 (1983)

The legislative authorities under which the U.S. Department of Energy (DOE) implements its remedial action programs and issues of concern are explored. DOE is presently implementing four remedial action programs designed to decontaminate both DOE-owned properties as well as other sites where the levels of radiation exceed "current criteria" for the unrestricted use of land and structures. The goal of all of these programs is the protection of public health and safety and the eventual certification of the sites for unrestricted use.

669

Myrick, T.E., M.S. Blair, R.W. Doane, and W.A. Goldsmith, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

A Mobile Gamma-Ray Scanning System for Detecting Radiation Anomalies Associated with Radium-226-Bearing Materials

ORNL/TM-8475; 84 pp. (1982, November)

A mobile gamma-ray scanning system has been developed by Oak Ridge National Laboratory for use in the U.S. Department of Energy's remedial action survey programs. The unit consists of a NaI(Tl) detection system housed in a specially-equipped van. The system is operator controlled through an on-board mini-computer, with data output provided on the computer video screen, strip chart recorders, and an on-line printer. Data storage is provided by a floppy disk system. Multi-channel analysis capabilities are included for qualitative radionuclide identification. A radium-226-specific algorithm is employed to identify locations containing residual radium-bearing materials. This report presents the details of the system description, software development, and scanning methods utilized with the ORNL system. Laboratory calibration and field testing have established the system sensitivity, field of view, and other performance characteristics, the results of which are also presented. Documentation of the instrumentation and computer programs are included. (Auth)

670

Napier, B.A., and W.E. Kennedy, Jr.

How Clean Is Clean Enough? - Allowable Residual Contamination Levels

Transactions of the American Nuclear Society 43:98-99; CONF-821103; Proceedings of an American Nuclear Society Winter Meeting, Washington, DC, November 14-18, 1982; (pp. 98-99) (1982)

A method for answering the question "how clean is clean enough?" in relation to cleanup of sites with radioactive contamination is presented. The method described is based on compliance with a radiation dose rate limit through a site-specific analysis of the potential for radiation exposure to individuals. The site-specific analysis is directed by the physical, environmental, and radiological characteristics of the contaminated area. This method is being used as a basis for calculating impacts and costs associated with various waste disposal alternatives that will be examined in the proposed Hanford Defense Waste Environmental Impact Statement.

671
Notz, K.J., Oak Ridge National Laboratory, Oak Ridge, TN

Radioactive Waste and Nuclear Power: A Personal Perspective

DOE/OR/21400-T60; 72 pp. (1984)

An overview is given of all major sources of radioactive materials in this country, including spent fuel, high-level waste, TRU waste, low-level waste, mill tailings, remedial action programs material, decontamination and decommissioning, and airborne waste. These materials are characterized in terms of location, volume, age, radioactivity, thermal power, physical properties, and chemical properties. The role of nuclear power in an oxidized and oxidizing world is discussed in terms of environmental benefits and the conservation of our limited supply of chemically reduced matter; i.e. material that can be oxidized or burned.

672
Notz, K.J., and J.A. Klein, Oak Ridge National Laboratory, Oak Ridge, TN

Integrated Data Base Program: A Status Report

ORNL/TM-9139; 26 pp. (1984, June)

The Integrated Data Base (IDB) Program provides official Department of Energy (DOE) data on spent fuel and radioactive waste inventories, projections, and characteristics. The accomplishments of FY 1983 are summarized for three broad areas: (1) upgrading and issuing of the annual report on spent fuel and radioactive waste inventories, projections, and characteristics, including ORIGEN2 applications and a quality assurance plan; (2) creation of a summary data file in user-friendly format for use on a personal computer and enhancing user access to program data; and (3) optimizing and documentation of the data handling methodology used by the IDB Program and providing direct support to other DOE programs and sites in data handling. Plans for future work in these three areas are outlined.

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Oak Ridge National Laboratory, Oak Ridge, TN

Spent Fuel and Radioactive Waste Inventories, Projections and Characteristics

DOE/NE-0017/2 (1983, September)

Current inventories and characteristics of commercial spent fuels and both commercial and DOE radioactive wastes are compiled through December 31, 1982. Future waste and spent fuel to be generated over the next 40 years and characteristics of these materials are also considered. Materials surveyed include spent fuel, high-level waste, transuranic waste, low-level waste, active uranium mill tailing, airborne waste, remedial action waste, and decommissioning waste. For each category, current and projected inventories are given through the year 2020, and the radioactivity and thermal power are calculated. Processing, packaging, treatment, and disposal options are briefly addressed.

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Oak Ridge National Laboratory, Oak Ridge, TN

Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics

DOE/RW-0006; DOE/NE-0017/3; 297 pp. (1984, September)

Current inventories and characteristics of commercial spent fuels and both commercial and U.S. Department of Energy (DOE) radioactive wastes were compiled through December 31, 1983, based on the most reliable information available from government sources and the open literature, technical reports, and direct contacts. Future waste and spent fuel to be generated over the next 37 years and characteristics of those materials are also present, consistent with the latest DOE/Energy Administration Information projection of U.S. commercial nuclear power growth and expected defense-related and private industrial and institutional activities. Materials considered, on a chapter-by-chapter basis, are:

spent fuel, high-level waste, transuranic waste, low-level waste, commercial uranium mill tailings, airborne waste, remedial action waste, and decommissioning waste. For each category, current and projected inventories are given through the year 2020, and the radioactivity and thermal power are calculated, based on reported or calculated isotopic compositions. (Auth)

675

Rudy, C.R., P.H. Jenkins, G.R. Hagee, J.B. Hall, and J.Y. Jarvis, Monsanto Research Corporation, Mound Facility, Miamisburg, OH

Outdoor Radon Monitoring at DOE Remedial Action Sites

MLM-3218; CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 27) (1984, November 7)

The Mound Facility radon program has performed extensive outdoor radon monitoring near six remedial action sites for the U.S. Department of Energy since 1980. The results of these environmental measurements indicate that yearly average background concentrations as low as 0.1 to 0.2 pCi/l can be determined using Passive Environmental Radon Monitors (PERM). This monitoring can also be used to map areas of increased radon concentrations and can be used to provide confirmation of the success of remedial action. Environmental monitoring can provide data that can be used for decision-making by government officials and the general public by replacing uncertainty with knowledge about radon concentrations in the vicinity of remedial action sites.

676

Nuclear Regulatory Legislation Through the 97th Congress, 2nd Session

R84000422; 282 pp.()

This compilation of existing law affecting the nuclear regulatory process and the U.S. Nuclear Regulatory Commission (NRC) was prepared as a reference document for legislators involved in nuclear oversight in these areas. The document contains legislation enacted through the 97th Congress, 2nd session, which pertains to nuclear regulation and the NRC, and includes the Atomic Energy Act of 1954, the Energy Reorganization Act of 1974, the Nuclear Waste Policy Act of 1982, recent NRC Authorization Acts, the Uranium Mill Tailings Radiation Control Act of 1978, the Low-Level Radioactive Waste Policy Act, and the West Valley Demonstration Project Act.

677

Sjoblom, G.L., D.J. Egan, Jr., R.H. Johnson, G.L. Meyer, S. Lichtman, and J.L. Russell, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

United States Environmental Protection Agency Radioactive Waste Disposal Standards

IAEA-CN-43/313; STI/PUB-649; CONF-830523; Radioactive Waste Management, Proceedings of an International Conference, Seattle, WA, May 16-20, 1983. International Atomic Energy Agency, Vienna, Vol. 4, 423 pp.; (pp. 135-147) (1984)

The U.S. Environmental Protection Agency (EPA) is in the process of developing and issuing generally applicable environmental standards for several categories of radioactive wastes. Standards for high-level and transuranic wastes have been proposed for public comment. Standards for disposal of low-level radioactive wastes by alternative methods are being developed. Standards for cleanup and disposal of uranium mill tailings waste at inactive sites have been issued and standards for active milling operations have been proposed for public comment. Regulations for ocean disposal of low-level radioactive waste are also being considered. The common purpose of these several efforts is long-term protection of the general public and the environment from the disposal of waste material generated during operations involving beneficial uses of radioactive material. Standards are derived through technical analysis of disposal alternatives, including potential for radiation exposure to the public through environmental transport, as well as the economic aspects. The process of developing standards involves inter-agency and public participation through publishing technical support information, public hearings, and obtaining written comments. The status of these EPA efforts and their relationship to those of other agencies and states is described.

CHAPTER 9. GENERAL REMEDIAL ACTION PROGRAM STUDIES

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Soldat, J.K., and D.H. Denham, Pacific Northwest Laboratory, Richland, WA

Review of Standards and Guidelines Pertinent to DOE's Remedial Action Programs

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984; (p. 22) (1984, November)

A number of radiological standards, guidelines, and dose criteria have been promulgated that may be relevant to the U.S. Department of Energy's Remedial Action Programs. Some of these will be applied to remedial actions undertaken by DOE to ensure that health and safety aspects will be adequately addressed. Pacific Northwest Laboratory staff are reviewing and evaluating existing and proposed environmental radiological standards and criteria for their applicability. National and international environmental standards and criteria, and studies conducted by other DOE contractors are being evaluated. The aim of the review is to identify gaps in these standards and guidelines and to recommend further development as necessary. This paper provides a summary of the standards and guidelines evaluated for applicability to DOE's Remedial Action programs. (Auth)(JWF)

679

Tasher, S.A., Donovan, Leisure, Newton and Irvine, Washington, DC

Site Negotiations: Lessons Learned

CONF-840488; Low-Level Nuclear Waste Cleanup, Proceedings of the Center for Energy and Environmental Management and Nuclear Waste News Conference, Arlington, VA, April 16-17, 1984 (1984, April)

Increased concern about the ability to adequately address environmental problems under the common law has led to a series of legislative initiatives which have mandated the investigation, reduction, and/or prevention of pollution and have established specific programs for cleaning up the environment. The paper discusses the role of the U.S. Environmental Protection Agency and its evolving enforcement policy and discusses considerations regarding settlement strategies. These considerations include a thorough evaluation of the problem, potential responsibilities, the type of agreement to be drafted, and the issue of apportionment. It was also suggested that the use of committees should be considered for joint negotiation in settlements, the creation of an information network, the litigation of issues of mutual interest, review of the scope of work for the government's cost estimates, the final design for cleanup, and all other information. (ARE)

680

U.S. Department of Energy, Office of Operational Safety, Washington, DC

Fifth DOE Environmental Protection Information Meeting

CONF-841187; Proceedings of the Fifth DOE Environmental Protection Information Meeting, Albuquerque, NM, November 6-8, 1984 (1984, November)

The Office of Operational Safety conducted the Fifth DOE Environmental meeting for U.S. Department of Energy personnel and DOE contractor personnel to provide a forum to discuss changing program requirements and common problems and solutions. (JWF)

681

U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

Draft Background Information Document: Proposed Standard for Radon-222 Emissions to Air from Underground Uranium Mines

EPA-520/1-85-010; 159 pp. (1985, February 14)

This document presents background data and other pertinent information on underground uranium mining and related emissions of radionuclides, the risks associated with these emissions, and methods for reducing the emissions. Information was compiled from the technical literature, previous studies by EPA and the Bureau of Mines, comments received from rulemaking notices, and discussions with industry representatives. It addresses the following six areas: (1) history and scope of standard development; (2) industry description: (3) atmospheric emission of radon-222; (4) estimating the risk due to exposure from radon-222 decay products; (5) risk assessment; and (6) control techniques. (JWF)

682

Welty, C.G., Jr., T.S. Needels, and D.H. Denham, U.S. Department of Energy, Office of Policy, Safety and Environment, Washington, DC; Pacific Northwest Laboratory, Office of Operational Safety, Richland, WA

DOE's Remedial Action Assurance Program

PNL-SA-12416S; 11 pp.; CONF-841105; Nuclear Power - A Global Reality, Proceedings of the American Nuclear Society and the European Nuclear Society International Conference and Winter Meeting, Washington, DC, November 11-16, 1984, 530 pp.; (pp. 54-55); Transactions of the American Nuclear Society 47:54-55 (1984, October)

The formulation and initial implementation of DOE's Assurance Program for Remedial Action are described. It was initiated in FY 1984 and is expected to be further implemented in FY 1985 as the activities of DOE's Remedial Action programs continue to expand. Further APRA implementation will include additional document reviews, site inspections, and program office appraisals with emphasis on Uranium Mill Tailings Remedial Action Program and Surplus Facilities Management Program.

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Winters, M.C.B., P. Merry-Libby, and R. Hinchman, Argonne National Laboratory, Environmental Research Division, Argonne, IL

Comparison of Long-Term Stability of Containment Systems for Residues and Wastes Contaminated with Naturally Occurring Radionuclides at an Arid Site and Two Humid Sites

CONF-850242; Management of Uranium Mill Tailings, Low-Level Waste and Hazardous Waste, Proceedings of the Seventh Symposium, Fort Collins, CO, February 6-8, 1985, 592 pp.; (pp. 311-323) (1985)

The long-term stability of near-surface containment systems designed for the management of radioactive wastes and residues contaminated with naturally occurring radionuclides are compared at the three different sites. The containment designs are: (1) a diked 8.9-m-high mound, including a 3.2-m layered cap at a site (humid) near Lewiston, New York; (2) a 6.8-m-high mound, including a similar 3.2-m cap at a site (humid) near Oak Ridge, Tennessee; and (3) 4.8-m deep trenches with 3.0-m backfilled caps at a site (arid) near Hanford, Washington. Geological, hydrological, and biological factors affecting the long-term (1000-year) integrity of the containment systems at each site are examined, including: erosion, flooding, drought, wildfire, slope and cover failure, plant root penetration, burrowing animals, other soil-forming processes, and land-use changes. For the containment designs evaluated, releases of radon-222 at the arid site are predicted to be several orders of magnitude higher than at the two humid sites at both initial burial and 1000 years (after severe erosion). Transfer of wastes containing naturally occurring radionuclides from a humid to an arid environment offers little or no advantage relative to long-term stability of the containment system and has a definite disadvantage in terms of gaseous radioactive releases. (Auth)(DCM)

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ACRONYMS

AAEC	Australian Atomic Energy Commission
AAECRE	Australian Atomic Energy Commission Research Establishment
AARR	Argonne Advanced Research Reactor
ACUS	Atlantic Council of the United States
ACWP	actual cost for work performed
ADM	action description memorandum
AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
AECB	Atomic Energy Control Board (Canada)
AECL	Atomic Energy of Canada Limited
AEE	Atomic Energy Establishment, United Kingdom Atomic Energy Authority, Winfrith, United Kingdom
AEMB	Alabama Energy Management Board
AEP	see AEPSC
AEPSC	American Electric Power Service Corporation
AERE	Atomic Energy Research Establishment, United Kingdom Atomic Energy Authority, Harwell, United Kingdom
AETF	Advanced Equipment Test Facility
AETR	Advanced Engineering Test Reactor, Idaho Falls, ID
AFL	Advanced Fuel Laboratory, General Electric Company, Sunnyvale, CA
AFL	Advanced Fuels Laboratory, Westinghouse Electric Company, Madison, PA
AFR	annual fuel requirement
AFR	away from reactor
AFRIMET	African Metals
AFRRI	Armed Forces Radiobiology Research Institute, Bethesda, MD
AFSR	Argonne Fast Source Reactor, National Reactor Testing Station, Idaho Falls, ID
AFWL	Air Force Weapons Laboratory
AG	Aktiengesellschaft
AGC	Aerojet General Corporation
AGN	Aerojet-General Nucleonics (designation for university research and teaching reactors)
AGNS	Allied-General Nuclear Services, Barnwell, SC
AGR	advanced gas-cooled reactor
AHCF	Aqueous Homogeneous Critical Facility (Japan)
AHFR	Argonne High Flux Reactor, Argonne National Laboratory, Argonne, IL
AHR	Aqueous Homogeneous Reactor
AI	Atomics International Division, Rockwell International Corporation
AICHE	American Institute of Chemical Engineers (also AICE)
AIEE	American Institute of Electrical Engineers
AIF	Atomic Industrial Forum, Bethesda, MD
AL	Ames Laboratory, Ames, IA
ALAP	as low as practical
ALARA	as low as reasonably achievable
ALO	Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, NM
ALPRR	Argonne Low Power Research Reactor, Argonne National Laboratory, Argonne, IL
ALRR	Ames Laboratory Research Reactor, Ames, IA
AMRAW	assessment method for radioactive waste (computer code)
AMS	Aerial Measuring Systems [Aerial Monitoring System]

ANC	Aerojet Nuclear Company, Idaho Falls, ID
ANDRA	Agence National pour la Gestion des Deschets Radioactifs, Commissariat a l'Energie Atomique (France)
ANI	American Nuclear Insurers, Farmington, CT
ANL	Argonne National Laboratory, Argonne, IL
ANP	Aircraft Nuclear Propulsion
ANPS	Agesta Nuclear Power Station (Sweden)
ANS	American Nuclear Society, LaGrange, IL
ANSI	American National Standards Institute, New York, NY
ANSPD	Advanced Nuclear Systems and Project Division, Mound Facility, Miamisburg, OH
AP&L	Arkansas Power and Light Company
APG	Aberdeen Proving Ground, Aberdeen, MD
APPA	American Public Power Association, Washington, DC
ARBOR	Argonne Boiling Water Reactor, National Reactor Testing Station, Idaho Falls, ID
ARCL	allowable residual contamination level
ARD	Advanced Reactor Division, Westinghouse Electric Corporation, Cheswick, PA
ARE	Aircraft Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, TN
ARHCO	Atlantic Richfield Hanford Company, Richland, WA
ARMS	Aerial Radiological Monitoring System
ARR	see AARR
ARSD	Advanced Reactor Systems Department, General Electric Company, Sunnyvale, CA
ART	Aircraft Reactor Test, Oak Ridge National Laboratory, Oak Ridge, TN
ARVFS	Army Re-entry Vehicle Facility Site
ASDP	Assistant Secretary for Defense Programs, U.S. Department of Energy
ASEP	Assistant Secretary for Environmental Protection, U.S. Department of Energy
ASME	American Society of Mechanical Engineers
ASNE	Assistant Secretary for Nuclear Energy, U.S. Department of Energy
ASPEN	Advanced System for Process Engineering (computer model)
ASTM	American Society of Testing Materials
ATAE	Aare-Tessin, Aktiengesellschaft fur Elektrizitat, Olten, Switzerland (also ATEL)
ATBI	Applied Technology of Barnwell, Inc., Barnwell, SC
ATHMA	U.S. Army Toxic and Hazardous Materials Agency
ATR	Advanced Test Reactor, Idaho National Engineering Laboratory, Idaho Falls, ID
AVR	Arbeitsgemeinschaft Versuchsreaktor, GmbH, Federal Republic of Germany
AWRE	Atomic Weapons Research Establishment (United Kingdom)
B&R	Burns and Roe Industrial Services Corporation, Paramus, NJ
B&V	Black and Veatch Consulting Engineers
B&W	Babcock and Wilcox Company, Lynchburg, VA
BAPL	Bettis Atomic Power Laboratory, West Mifflin, PA
BAPU	see CNRS
BARC	Bhabha Atomic Research Centre, Bombay, India
BBC	Brown, Boveri, and Cie., Baden, Switzerland
BBCO	Bridgeport Brass Company, Bridgeport, CT

BCL	Battelle Columbus Laboratories, Columbus, OH
BCWS	budgeted cost for work scheduled
BEC	Boeing Engineering and Construction Company
BEIR	biological effects of ionizing radiation
BFEC	Bendix Field Engineering Corporation, Grand Junction, CO
BFNPS	Browns Ferry Nuclear Power Station, Decatur, AL
BG&E	Baltimore Gas and Electric, Baltimore, MD
BGA	Bundesgesundheitsamt [German Federal Health Office] (Federal Republic of Germany)
BI	Battelle Institute, Frankfurt, Federal Republic of Germany
BIH	Bundesminister des Innern, Bonn, Federal Republic of Germany
BMFT	Bundesministerium fur Forschung und Technologie, Bonn, Federal Republic of Germany
BMI	Battelle Memorial Institute, Columbus, OH
BNF	Barnwell Nuclear Fuel Plant, Barnwell, SC
BNFL	British Nuclear Fuels Limited (United Kingdom)
BNFP	Barnwell Nuclear Fuel Plant, Barnwell, SC
BNI	Bechtel National, Inc.
BNL	Berkeley Nuclear Laboratories, Central Electricity Generating Board, Berkeley, United Kingdom
BNL	Brookhaven National Laboratory, Upton, NY
BNWL	Battelle Northwest Laboratories, Richland, WA (now PNL)
BOM	U.S. Bureau of Mines
BONUS	Boiling Nuclear Superheater Power Station, Punta Higuera, PR
BORAX	Boiling Reactor Experiment, National Reactor Testing Station, Idaho Falls, ID
BPC	Bechtel Power Corporation, San Francisco, CA
BRE	Boiling Reactor Experiment, Idaho National Engineering Laboratory, Idaho Falls, ID
BRISC	Burns and Row Industrial Services Corporation
BRP	Breeder Reactor Program
BRPNS	Big Rock Point Nuclear Plant, Big Rock Point, MI
BVPS	Beaver Valley Power Station, Shippingport, PA
BWAG	Bayernwerk AG, Muenchen, Federal Republic of Germany
BWR	boiling-water reactor
C	Celsius (temperature)
CAA	Clean Air Act
CAB	Commonwealth Agricultural Bureau (United Kingdom)
CAMEN	Centro Autonomo Militari Energia Nucleare (Italy)
CANDU	Canadian Deuterium Uranium reactor type (natural uranium heavy water moderated and cooled power reactor)
CANMET	Canada Centre for Mineral and Energy Technology
CAS	Chemical Abstracts Service (abstract journal and database) Columbus, OH
CCE	Commission des Communautes Europeennes, Brussels, Belgium
CCE	Commissione delle Comunita Europee, Ispra, Italy
CCR	Centro Comunie di Ricerca, Commissione delle Comunita Europee, Ispra, Italy
CDR	conceptual design report
CE	Combustion Engineering, Inc., Windsor, CT
CEA	Commissariat a l'Energie Atomique (France)
CEAN	Centre d'Etudes pour les Applications de l'Energie Nucleaire (Belgium)
CEC	Commission of the European Communities

CEC	Commonwealth Edison Company
CEDRA	Societe Cooperative Nationale pour l'Entreposage de Dechets Radioactifs, Baden, Federal Republic of Germany
CEEN	see CEN
CEER	Center for Energy and Environment Research (Puerto Rico)
CEGB	Central Electricity Generating Board (United Kingdom)
CEN	Centre d'Etude de l'Energie Nucleaire, Brussels, Belgium (also CEEN)
CEP	Controls for Environmental Pollution, Inc., Santa Fe, NM
CEQ	Council on Environmental Quality
CERF	contaminated equipment repairs facility
CERMET	ceramic and metal
CERN	European Organization for Nuclear Research (English translation)
CEVR	contaminated equipment volume reduction
CEW	Clinton Engineer Works, Clinton, TN (MED)
CFR	Code of Federal Regulations
CHO	U.S. Department of Energy, Chicago Operations Office, Argonne, IL
CIINE	Interministerial Commission for the Basic Nuclear Facilities (France)
CIS	Congressional Information Service
CISE	Centro Informazioni Studi Esperienze (Italy)
CISRA	Societa Cooperativa Nationale per l'Immagazzinamento di Scorie Radioattive, Baden, Federal Republic of Germany
CIT	California Institute of Technology
CMSA	Chamber of Mines of South Africa, Auckland Park, South Africa
CNEA	Comision Nacional de Energia Atomica (Mexico, Argentina)
CNEN	Comision Nacional de Energia Nuclear (Mexico)
CNEN	Comitato Nazionale per l'Energia Nucleare (Italy)
CNRN	Comitato Nazionale per le Ricerche Nucleari (Italy)
CNRS	Centre National de la Recherche Scientifique (France)
CNRS	Comitato Nazionale per la Ricerca e per lo Sviluppo, Rome, Italy
COEGMA	Compagnie Generale des Matieres Nucleaires (France)
COMB	see CNRS
COMMED	Commonwealth Edison Company
COMPENDEX	Computerized Engineering Index (bibliographic database)
CONED	Consolidated Edison Company
CP	Chicago Pile, Chicago, IL
CP&L	Carolina Power and Light Company, Raleigh, NC
CPAF	cost plus award fee
CPC	Consumers Power Corporation or Company
CPFF	cost plus fixed fee
CPPD	Consumers Public Power District (Nebraska)
CPUC	California Public Utilities Commission, San Francisco, CA
CRBRP	Clinch River Breeder Reactor Project, Oak Ridge, TN
CREC	see CNRS
CRIEPI	Central Research Institute of Electric Power Industry (Japan)
CRNL	Chalk River Nuclear Laboratories, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada
CRT	cathode-ray tube
CSM	Colorado School of Mines, Golden, CO
CSU	Colorado State University, Fort Collins, CO
CTH	Chalmers Tekniska Hoegskola, Institutionen foer Energiteknik, Goeteborg, Sweden
CVTR	Carolinas-Virginia Tube Reactor, Parr, SC

CY	calendar year
D&D	decontamination and decommissioning
D&M	Dames and Moore, Inc.
D2O	heavy water (deuterium oxide [H-2])
DAO	U.S. Department of Energy, Dayton Area Office, Dayton, OH
DAS	data acquisition system
DBMS	database management system
DDS	decommissioning data system
DECO	Detroit Edison Company, Detroit, MI
DECON	immediate decontamination option
DEIS	draft environmental impact statement
DEMR	Department of Energy, Mines and Resources, Canada Centre for Mineral and Energy Technology, Canada
DERE	Dounreay Experimental Reactor Establishment (United Kingdom)
DF	decontamination factor
DFR	Dounreay Fast Reactor (United Kingdom)
DGA	Delegation Generale pour l'Armement, Paris, France
DHHS	Department of Health and Human Services, National Institutes of Health, Public Health Service, Bethesda, MD
DISP	see ENEA
DMA	Division of Military Application
DNA	Defense Nuclear Agency, Washington, DC
DNA	data not available
DNPDE	Dounreay Nuclear Power Development Establishment, United Kingdom Atomic Energy Authority, Dounreay, United Kingdom
DNS	Dresden Nuclear Station, Morris, IL
DO	dismantling operations
DOC	U.S. Department of Commerce
DOC	decommissioning operations contractor
DOE	Department of the Environment (United Kingdom)
DOE	U.S. Department of Energy
DOE-AL	U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM
DOE-ALO	U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM
DOE-CH	U.S. Department of Energy, Chicago Operations Office, Argonne, IL
DOE-CHO	U.S. Department of Energy, Chicago Operations Office, Argonne, IL
DOE-DP	U.S. Department of Energy, Defense Programs
DOE-EP	U.S. Department of Energy, Environmental Protection
DOE-HDQ	U.S. Department of Energy, Washington, DC
DOE-ID	U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID
DOE-IDO	U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID
DOE-NE	U.S. Department of Energy, Nuclear Energy
DOE-NV	U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV
DOE-NVO	U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV
DOE-OGC	U.S. Department of Energy, Office of General Counsel, Washington, DC
DOE-OR	U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN
DOE-ORO	U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN
DOE-RL	U.S. Department of Energy, Richland Operations Office, Richland, WA
DOE-RLO	U.S. Department of Energy, Richland Operations Office, Richland, WA
DOE-SAN	U.S. Department of Energy, San Francisco Operations Office, Oakland, CA
DOE-SF	U.S. Department of Energy, San Francisco Operations Office, Oakland, CA

DOE-SFO	U.S. Department of Energy, San Francisco Operations Office, Oakland, CA
DOE-SR	U.S. Department of Energy, Savannah River Operations Office, Aiken, SC
DOE-SRO	U.S. Department of Energy, Savannah River Operations Office, Aiken, SC
DOE-WVPO	U.S. Department of Energy, West Valley Project Office, West Valley, NY
DORF	Diamond Ordnance Radiation Facility, Forest Glen, MD
DOT	U.S. Department of Transportation
DPM	disintegrations per minute
DPS	disintegrations per second
DPTE	double door for hermetic transfer (translation from French)
DRAP	Division of Remedial Action Projects, U.S. Department of Energy
DRI	Desert Research Institute, Las Vegas, NV
DWBM	Defense Waste and Byproducts Management, U.S. Department of Energy
DWPF	Defense Waste Processing Facility
EA	environmental assessment
EAEC	European Atomic Energy Community (Italy)
EBR	Experimental Breeder Reactor, Idaho National Engineering Laboratory, Idaho Falls, ID
ECN	Energieonderzoek Centrum Nederland, Petten, The Netherlands (see NERF)
EDB	Energy Data Base (abstract journal and database by TIC)
EDP	environmental development plan
EDTA	ethylene diaminetetracetic acid
EE	Economisez l'Energie, Lausanne, Switzerland
EEI	Edison Electric Institute
EFAPP	Enrico Fermi Atomic Power Plant, Newport, MI
EG&G	EG&G Idaho, Inc., Idaho Falls, ID (Edgerton, Germeshausen and Grier)
EGCR	Experimental Gas Cooled Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
EI	see EIX
EIA	environmental impact assessment
EIC	Eberline Instrument Corporation
EIHNP	Edwin I. Hatch Nuclear Plant, Baxley, GA
EIR	Eidgenoessisches Institut fuer Reaktorforschung (Switzerland)
EIS	environmental impact statement
EIX	Engineering Index (abstract journal and database)(also EI)
EMG	Energy Measurements Group, EG&G, Inc., Las Vegas, NV
EML	Environmental Measurement Laboratory, New York, NY
ENC	Exxon Nuclear Corporation
ENEA	European Nuclear Energy Agency
ENEL	Ente Nazionale per l'Energia Elettrica (Italy)
ENFDP	evaluation of nuclear facility decommissioning projects
ENICO	Exxon Nuclear Idaho Company, Inc., Idaho Falls, ID
ENS	European Nuclear Society
ENTOMB	entombment option
ENUSA	Energie Nucleaire S.A. Lausanne, Switzerland
EOCR	Experimental Organic Cooled Reactor, Idaho National Engineering Laboratory, Idaho Falls, ID
EOS	S.A. l'Energie de l'Ouest Suisse, Lausanne, Switzerland
EOSSA	see EOS
EP	environmental protection
EPA	U.S. Environmental Protection Agency
EPA	engineering, planning, administration
EPDM	ethylene propylene diene monomers (cover materials)

EPP	exportable pyrochemical process
EPRI	Electric Power Research Institute, Palo Alto, CA
EPS	Environmental Protection Service, Environment Canada, Ottawa, Ontario, Canada
EPTR	Experimental Propulsion Test Reactor, Nevada Test Site, Mercury, NV
ERC	Evaluation Research Corporation, Oak Ridge, TN
ERDA	U.S. Energy Research and Development Administration
ERR	Elk River Reactor, Elk River, MN
ESG	Energy Systems Group, Rockwell International Corporation
ETEC	Energy Technical Engineering Center (formerly LMEC)
ETR	Engineering Test Reactor, Idaho National Engineering Laboratory, Idaho Falls, ID
EURATOM	European Atomic Energy Community
EUROCHEMIC	European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium
F	Fahrenheit (temperature)
FAPIG	First Atomic Power Industry Group, Tokyo, Japan
FBDU	Ford, Bacon and Davis Utah, Inc., Salt Lake City, UT
FBR	fast breeder reactor
FEMA	Federal Emergency Management Administration, Washington, DC
FERC	Federal Energy Regulatory Commission, Washington, DC
FES	final environmental statement
FFTF	Fast Flux Test Facility, Richland, WA
FGD	flue gas desulfurization
FIRR	Federal Institute for Reactor Research (Switzerland)
FLPMA	Federal Land Policy Management Act
FMPC	Feed Materials Production Center, NLO, Inc., Fernald, OH
FNAL	Fermi National Accelerator Laboratory, Batavia, IL
FONSI	finding of no significant impact
FP&L	Florida Power and Light Company
FPDL	Fission Products Development Laboratory, Oak Ridge National Laboratory, Oak Ridge, TN
FPPP	Fission Product Pilot Plant, Oak Ridge National Laboratory, Oak Ridge, TN
FPS	Fluor Power Services, Inc.
FRC	Federal Radiation Council (now part of EPA)
FRG	Federal Republic of Germany
FRN	Forschungsreaktors Neuherberg (reactor)(Federal Republic of Germany)
FTC	Fuels Technology Center, Argonne National Laboratory, Argonne, IL
FUSRAP	Formerly Utilized Sites Remedial Action Program, U.S. Department of Energy
FWPCA	Federal Water Pollution Control Administration (now FWQA)
FWQA	Federal Water Quality Administration (formerly FWPCA)
FY	fiscal year
G&H	Gibbs and Hill, Inc.
GA	General Atomic Company, San Diego, CA
GAC	Goodyear Aerospace Corporation, Akron, OH
GAO	U.S. General Accounting Office, Washington, DC
GCHWR	gas cooled heavy water reactor
GDCD	Generation, Development, and Construction Division, Central Electricity Generating Board (United Kingdom)
GDR	German Democratic Republic
GE	General Electric Company

GECR	Geochemistry and Environmental Chemistry Research, Inc., Rapid City, SD
GEEE	Ground Experimental Engine Experiment, Nuclear Rocket Development Station, Nevada Test Site, NV
GEFL	General Electric Fuels Laboratory, Pleasanton, CA
GEIS	generic environmental impact statement
GESMO	Generic Environmental Statement on Mixed Oxides
GETR	General Electric Testing Reactor, Pleasanton, CA
GI	gastro-intestinal
GJAO	Grand Junction Area Office, U.S. Department of Energy, Grand Junction, CO
GJO	see GJAO
GJRAP	Grand Junction Remedial Action Program, U.S. Department of Energy
GJVP	Grand Junction Vicinity Properties
GKSS	Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt (Federal Republic of Germany)
GM	Geiger-Muller (radiation counter)
GMAW	gas metal (spray) arc welding
GPO	U.S. Government Printing Office
GPU	General Public Utilities
GRA	Government Reports Announcements (abstract journal and database by NTIS)
GRS	Gesellschaft fuer Reaktorsicherheit mbH, Koeln, Federal Republic of Germany
GSA	General Services Administration
GST	Gunite Storage Tanks, Oak Ridge National Laboratory, Oak Ridge, TN
GTAW	gas tungsten arc welding
GUW	Gesellschaft fur Umweltuberwachung mbH, Aldenhoven, Federal Republic of Germany
HAPO	Hanford Atomic Products Operations, Richland, WA
HBPP	Humboldt Bay Power Plant, Eureka, CA
HCDWNP	Hazardous Chemical Defense Waste National Program
HEC	Hooker Electrochemical Company
HEDL	Hanford Engineering Development Laboratory, Richland, WA
HEPA	high efficiency particulate air
HEW	Hanford Engineer Works, Richland, WA (MED)
HFIR	High Flux Isotope Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
HIT	Hauptabteilung Ingenieurtechnik, Federal Republic of Germany
HL&P	Houston Light and Power Company, Houston, TX
HLW	high-level (radioactive) waste
HMIC	Hazardous Materials Information Center, Oak Ridge National Laboratory, Oak Ridge, TN
HNL	Holifield National Laboratory (now ORNL)
HNPF	Hallam Nuclear Power Facility, Hallam, NE
HP	health physics or health physicist
HPS	Health Physics Society
HRE	Homogeneous Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, TN
HRT	Homogeneous Reactor Test, Oak Ridge National Laboratory, Oak Ridge, TN
HSK	Hauptabteilung fur die Sicherheit der Kernanlagen, Wurenlingen, Switzerland (see SFOE)
HT	high tensile

HTGR	High-Temperature Gas-Cooled Reactor
HTR	Hanford Test Reactor, Richland, WA
HTRE	Heat Transfer Reactor Experiment, Idaho National Engineering Laboratory, Idaho Falls, ID
HVAC	heating, ventilation air conditioning
HWCTR	Heavy Water Components Test Reactor, Savannah River Laboratory, Aiken, SC
HX	heat exchanger
IAEA	International Atomic Energy Agency, Vienna, Austria
ICC	Information Center Complex, Oak Ridge National Laboratory, Oak Ridge, TN
ICONS	Information Center on Nuclear Standards (ANS)
ICPP	Idaho Chemical Processing Plant, Idaho Falls, ID
ICRP	International Commission on Radiological Protection
ID	inside diameter
IDB	Integrated Data Base
IDO	Idaho Operations Office, U.S. Department of Energy, Idaho Falls, ID
IEA	International Energy Agency
IEC	Intera Environmental Consultants, Inc., Houston, TX
IEEE	Institute of Electrical and Electronics Engineers
IET	Initial Engine Test, Idaho National Engineering Laboratory, Idaho Falls, ID
IHX	intermediate heat exchanger
ILW	intermediate-level (radioactive) waste
INC	Idaho Nuclear Corporation, Idaho Falls, ID
INEL	Idaho National Engineering Laboratory, Idaho Falls, ID
INIS	International Nuclear Information System
INPO	Institute of Nuclear Power Operations, Atlanta, GA
INSPEC	Information Services in Physics, Electrotechnology, Computers and Control (database)
IPS	Indian Point Station, Buchanan, NY
IPSN	Institute de Protection et de Surete Nucleaire, Commissariat a l'Energie Atomique (France)
ISFSI	independent spent fuel storage installations
ITRI	Inhalation and Toxicology Research Institute, Lovelace Biomedical and Environmental Research Institute, Albuquerque,NM
JAERI	Japan Atomic Energy Research Institute
JAFNPP	James A. FitzPatrick Nuclear Power Plant, Scriba, NY
JCP&L	Jersey Central Power and Light Company
JEG	Jacobs Engineering Group, Inc., Albuquerque, NM
JEN	Junta de Energia Nuclear, Madrid, Spain
JMFNP	Joseph M. Farley Nuclear Plant, Dothan, AL
JMTR	Japan Material Testing Reactor
JNRC	Joint Nuclear Research Center, Ispra, Italy
JPDRF	Japan Power Demonstration Reactor, Ibaraki, Tokai-Mura, Japan
JPL	Jet PropulsionLaboratory, U.S. National Aeronautics and Space Administration, Palo Alto, CA
JRC	Jet Research Corporation
K	Kelvin (temperature)
K-25	former site designation of Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN
KA	Kraftanlagen Aktiengesellschaft, Heidelberg, Federal Republic of Germany

KAFB	Kirtland Air Force Base, Albuquerque, NM
KAPL	Knolls Atomic Power Laboratory, Schenectady, NY
KBG	Kernkraftwerk-Betriebsgeselischaft (Federal Republic of Germany)
KEMA	Keuring van Electrotechnische Materialen, N.V., Arnhem, Netherlands
KEPCO	Kansas Electric Power Cooperative, Inc., Topeka, KS
KEWB	Kinetic Experiment on Water Boilers, Santa Susana Field Laboratories, Canoga Park, CA
KFA	Kernforschungsanlage Julich GmbH, Julich, Federal Republic of Germany
KFK	Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, Federal Republic of Germany
KGB	Kernkraftwerk Gundremmingen Betriebsgesellschaft mbH, Gundremmingen, Federal Republic of Germany
KIWI	Nuclear Rocket Engine Reactor Experiment, Nuclear Rocket Development Station, Nevada Test Site, NV
KKN	Kernkraftwerk Niederaichbach (Federal Republic of Germany)
KKN-PB	Kernkraftwerk Niederaichbach Projektbereich (Federal Republic of Germany)
KLAG	Kernkraftwerk Leibstadt AG, Leibstadt, Federal Republic of Germany
KRB	Kernkraftwerk-RWE-Bayernwerk, Gundremmingen, Federal Republic of Germany
KUA	Kraftwerk Union Aktiengesellschaft, Offenbach, Federal Republic of Germany
LAMPRE	Los Alamos Molten Plutonium Reactor Experiment, Los Alamos National Laboratory, Los Alamos, NM
LANL	Los Alamos National Laboratory, Los Alamos, NM (formerly LASL)
LAP	Linde Air Products Company, Tonawanda, NY (also LAPC)
LAPRE	Los Alamos Plutonium Reactor Experiment, Los Alamos National Laboratory, Los Alamos, NM
LASL	Los Alamos Scientific Laboratory, Los Alamos, NM (now LANL)
LATA	Los Alamos Technical Associates, Inc., Los Alamos, NM
LBERI	Lovelace Biomedical and Environmental Research Institute, Albuquerque, NM
LBL	Lawrence Berkeley Laboratory, Berkeley, CA (now LBNL)
LBNL	Lawrence Berkeley National Laboratory, Berkeley, CA (formerly LBL)
LC	Library of Congress
LER	Lucens Experimental Reactor, Lucens, Switzerland
LER	licensee event report
LILCO	Long Island Lighting Company
LITR	Low Intensity Test Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
LLD	lower limit of detection
LLL	Lawrence Livermore Laboratory, Livermore, CA (now LLNL)
LLNL	Lawrence Livermore National Laboratory, Livermore, CA (formerly LLL)
LLRW	low-level radioactive waste
LLW	low-level (radioactive) waste
LLWPA	Low Level Waste Policy Act (1980)
LMFBR	liquid metal fast breeder reactor
LNPS	Lingen Nuclear Power Station, Lingen, Federal Republic of Germany
LNS	London Nuclear Services, Inc., Niagara Falls, NY
LOCA	loss of coolant accident
LOFT	Loss of Fluid Test, Idaho National Engineering Laboratory, Idaho Falls, ID
LOOW	Lake Ontario Ordnance Works, Lewiston, NY
LOSA	Lake Ontario Storage Area, Lewiston, NY

LRC	Lewis ResearchCenter, U.S. National Aeronautics and Space Administration, Cleveland, OH
LSA	low specific activity
LT	long ton
LTFL	Low Temperature Fissiochemical Loop (Japan)
LWBR	light-water breeder reactor
LWR	light-water reactor
MCS	management control system
MCW	Mallinckrodt Chemical Works, St. Louis, MO
MDA	minimum detectable activity
MDC	minimum detectable concentration
MED	Manhattan Engineer District (1942-1947)
MIT	Massachusetts Institute of Technology, Cambridge, MA
MITI	Ministry of International Trade and Industry (Japan)
MK	Morrison-Knudsen Company, Inc. (also MKC)
MMD	mass median diameter
MNGP	Monticello Nuclear Generating Plant, Monticello, MN
MOU	memorandum of understanding
MOX	mixed oxide (fuel)
MRC	Monsanto Research Corporation
MRF	Metal Recovery Facility, Oak Ridge National Laboratory, Oak Ridge, TN
MSL	Molten Salt Loop, Oak Ridge National Laboratory, Oak Ridge, TN
MSM	master-slave manipulator
MSP	Middlesex Sampling Plant, Middlesex, NJ
MSPS	Middlesex Sampling Plant Site, Middlesex, NJ
MSR	molten salt reactor (see MSRE)
MSRE	Molten Salt Reactor Experiment, Oak Ridge National Laboratory, Oak Ridge, TN
MSRL	Maritime Ship Reactor Loop, Oak Ridge National Laboratory, Oak Ridge, TN
MSU	Middle South Utilities
MT	metric ton
MTR	Materials Testing Reactor, Idaho National Engineering Laboratory, Idaho Falls, ID
MTR	Materials Testing Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
MTU	millions tons of uranium
MWT	megawatt thermal
NAEG	Nevada Applied Ecology Group, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV
NAEIC	Nevada Applied Ecology Information Center, Oak Ridge National Laboratory, Oak Ridge, TN
NAGRA	Nationale Genossenschaft fur die Lagerung Radioaktiver Abfalle, Baden, Federal Republic of Germany
NAIG	Nippon Atomic Industry Group (Japan)
NAK	sodium-potassium alloy
NAL	National Accelerator Laboratory, Batavia, IL (see FNAL)
NAPS	North Anna Power Station, Mineral, VA
NAS	National Academy of Sciences
NASA	U.S. National Aeronautics and Space Administration
NBL	New Brunswick Laboratory, New Brunswick, NJ
NBS	National Bureau of Standards
NCRP	National Council on Radiation Protection

NCSL	National Conference of State Legislatures, Denver, CO
NCSR	National Council for Scientific Research, Lusaka, Zambia
NEA	Nuclear Energy Agency, Paris, France
NEPA	National Environmental Policy Act
NERC	Centre d'Etudes de l'Energie Nucleaire (Belgium)
NERF	Netherlands Energy Research Foundation, Petten, Netherlands (see ECN)
NERVA	Nuclear Engine for Rocket Vehicle Application (see NRX)
NES	Nuclear Energy Services, Inc.
NFO	Nuclear Fuel Operations
NFS	Nuclear Fuel Services, Inc.
NFSS	Niagara Falls Storage Site, Niagara Falls, NY
NIAC	Nuclear Information and Analysis Center (DOD)
NIH	National Institutes of Health, Bethesda, MD
NII	Nuclear Installations Inspectorate (United Kingdom)
NIRA	National Institute of Research Advancement (Japan)
NIRP	National Institute of Radiation Protection, Stockholm, Sweden
NIS	Nuklear-Ingenieur-Service GmbH (Federal Republic of Germany)
NLCO	National Lead Company of Ohio, Cincinnati, OH (now NLO)
NLO	National Lead of Ohio, Cincinnati, OH (see NLCO)
NMEID	New Mexico Environmental Improvement Division
NMPNS	Nine Mile Point Nuclear Station, Scriba, NY
NNCL	National Nuclear Corporation Limited, Risley, United Kingdom
NNPS	Niederaichbach Nuclear Power Station (Federal Republic of Germany) (see KKN)
NOK	Nordostschweizerische Kraftwerke AG, Baden, Federal Republic of Germany
NORM	naturally occurring radioactive materials
NOTS	Naval Ordnance Test Station
NPMC	NEPA Process Management Contractor
NPP	nuclear power plant
NPPD	Nebraska Public Power District
NPR	nuclear power reactor
NPS	nuclear power station
NPS	nuclear powered ship
NRC	U.S. Nuclear Regulatory Commission
NRDS	Nuclear Rocket Development Station, Nevada Test Site, NV
NREST	Nuclear Rocket Engine System Test, Nuclear Rocket Development Station, Nevada Test Site, NV
NRL	Naval Research Laboratory, Washington, DC
NRO	Naval Reactors Operations Office
NRP	nuclear reactor program
NRPB	National Radiological Protection Board (United Kingdom)
NRR	nuclear rocket reactor
NRTS	National Reactor Testing Station, Idaho Falls, ID
NRX	Nuclear Rocket Engine Reactor Experiment, Nuclear Rocket Development Station, Nevada Test Site, NV
NS	nuclear ship
NSA	Nuclear Science Abstracts (abstract journal and computerized database)
NSAC	Nuclear Safety Analysis Center, Electric Power Research Institute, Palo Alto, CA
NSIC	Nuclear Safety Information Center, Oak Ridge National Laboratory, Oak Ridge, TN

NSMH	Nuclear Systems Materials Handbook
NSP	Northern States Power, Minneapolis, MN
NSPP	Nuclear Safety Pilot Plant, Oak Ridge National Laboratory, Oak Ridge, TN
NSW	New South Wales, Australia
NTIS	National Technical Information Service, Springfield, VA
NTS	Nevada Test Site, Mercury, NV
NU	Northeast Utilities, Hartford, CT
NUKEM	Nuklear-Chemie und Metallurgie GmbH (Federal Republic of Germany)
NUMEC	Nuclear Materials and Equipment Corporation, Apollo, PA
NUREG	publications of the U.S. Nuclear Regulatory Commission
NUS	National Utility Service, Inc.
NVO	Nevada Operations Office, U.S. Department of Energy, Las Vegas, NV
NWPA	Nuclear Waste Policy Act of 1982
NWTS	National Waste Terminal Storage
NWVP	Nuclear Waste Vitrification Project
OCDE	Organisation de Cooperation et de Developpment Economiques, Paris, France (see OECD)
OCNPP	Oyster Creek Nuclear Power Plant, Toms River, NJ
ODWBM	see DWBM
OECD	Organization for Economic Cooperation and Development, Paris, France
OFS	Osterreichisches Forschungszentrum Seibersdorf GmbH, Seibersdorf, Austria
OGC	Office of General Counsel, U.S. Department of Energy
OGR	Old Graphite Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
OHF	Old Hydrofracture Facility, Oak Ridge National Laboratory, Oak Ridge, TN
OKG	Oskarshamnsverkets Kraft Grupp Aktiebolag (Sweden)
OMA	Office of Military Applications, U.S. Department of Energy
OMR	organic moderated reactor
OMRE	Organic Moderated Reactor Experiment, Idaho National Engineering Laboratory, Idaho Falls, ID
ONP	Oconee Nuclear Plant, Seneca, SC
ONTHYD	Ontario Hydro
ONWI	Office of Nuclear Waste Isolation, Battelle Columbus Laboratories, Columbus, OH
ORAU	Oak Ridge Associated Universities, Oak Ridge, TN
ORGDP	Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN
ORNL	Oak Ridge National Laboratory, Oak Ridge, TN
ORO	Oak Ridge Operations Office, U.S. Department of Energy, Oak Ridge, TN
ORP	Office of Radiation Programs, U.S. Environmental Protection Agency
ORR	Oak Ridge Research Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
OSFM	Office of Surplus Facilities Management, UNC Nuclear Industries, Richland, WA
OSHA	Occupational Safety and Health Administration
OWI	Office of Waste Isolation (now ONWI)
PAC	plasma arc cutting
PASNY	Power Authority of the State of New York
PBAPS	Peach Bottom Atomic Power Station, Peach Bottom, PA
PBRF	Plum Brook Reactor Facility, Sandusky, OH
PCD	polymeric carrier delivery
PDR	program requirements document
PEAG	Preussen Elektrazitats-Aktiengesellschaft, Hannover, Federal Republic of Germany

PECO	Philadelphia Electric Company, Philadelphia, PA
PEP	power expansion program
PERM	passive environmental radon monitor
PFDL	Plutonium Fuel Division Laboratories, Westinghouse Electric Corporation, Cheswick, PA
PFF	Plutonium Fabrication Facility, Argonne National Laboratory, Argonne, IL
PFR	prototype fast reactor
PG&E	Pacific Gas and Electric Company
PGE	Portland General Electric
PGS	Pathfinder Generating Station, Sioux Falls, SD
PGS	Pickering Generating Station, Lake Ontario, Ontario, Canada
PHS	Public Health Service, National Institutes of Health, Bethesda, MD
PHWR	pressurized heavy water reactor
PIC	pressurized ion chamber
PINGP	Prairie Island Nuclear Generating Plant, Red Wing, MN
PIRG	Public Interest Research Group
PMC	project management contractor
PNC	Power Reactor and Nuclear Fuel Development Corporation (Japan)
PNL	Pacific Northwest Laboratory, Richland, WA (formerly BNWL)
PNPF	Piqua Nuclear Power Facility, Piqua, OH
PNPS	Pilgrim Nuclear Power Station, Plymouth, MA
PNRO	Pittsburgh Naval Reactor Office, U.S. Department of Energy, Pittsburgh, PA
PP	plutonium processing
PP&L	Pennsylvania Power and Light Company
PPFP	Palos Park Forest Preserve, Palos Park, IL
PRCF	Plutonium Recycle Critical Facility, PNL, Richland, WA
PRNC	Puerto Rico Nuclear Center
PRTR	Plutonium Recycle Test Reactor, Richland, WA
PRWRA	Puerto Rico Water Resources Authority, San Juan, PR
PSAR	Preliminary Safety Analysis Report
PSE&G	Public Service Electric and Gas, Salem, NJ
PSI	Public Service of Indiana
PTIF	Pneumatic Tube Irradiation Facility, Oak Ridge National Laboratory, Oak Ridge, TN
PUK	Pechiney Ugine Kuhlmann, Paris, France
PWR	pressurized-water reactor
PWTF	Plutonium-contaminated Waste Treatment Facility (Japan)
QA	quality assurance
QAA	quality assurance assessment
QAP	quality assurance plan
QC	quality control
R&D	research and development
R&T	research and test
RA	remedial action
RAC	remedial action contractor
RAEC	Rogers and Associates Engineering Corporation, Salt Lake City, UT
RAECO	radon attenuation effectiveness and cost optimization (computer code)
RAL	Rio Algom Limited, Elliot Lake, Ontario, Canada
RAP	Remedial Action Program, U.S. Department of Energy
RAPIC	Remedial Action Program Information Center, Oak Ridge National Laboratory, Oak Ridge, TN

RAPO	Remedial Action Program Office, U.S. Department of Energy (now DRAP)
RASA	Radiological Survey Activities (formerly RASCA)
RASCA	Remedial Action Survey and Certification Activities (now RASA)
RATF	Radon Attenuation Test Facility
RCRA	Resource Conservation and Recovery Act
RDC	radon daughter concentration
RED	referencable engineering document
REECO	Reynolds Electrical and Engineering Company, Inc., Las Vegas, NV
REM	radiometric emanation method
RFP	Rocky Flats Plant, Rockwell International, Golden, CO
RFP	request for proposal
RHO	Rockwell Hanford Operations, Richland, WA
RI	Rockwell International Corporation
RKS	Radet for Karnkraftsakerhet (Sweden)
RLO	Richland Operations Office, U.S. Department of Energy, Richland, WA
RMC	Radiation Management Corporation
RMDF	Radioactive Materials Disposal Facility, Atomics International Division, Rockwell International, Canoga Park, CA
RMEC	Rocky Mountain Energy Company (Colorado)
RNPDE	Risley Nuclear Power Development Establishment, United Kingdom Atomic Energy Authority, Risley, United Kingdom
RNPS	Ringhals Nuclear Power Station (Sweden)
RPISU	radon progeny integrating sampling unit
RPV	reactor pressure vessel
RRR	reference research reactor
RSL	Remote Sensing Laboratory, EG&G, Inc., Energy Measurements Group, Las Vegas, NV
RTI	Research Triangle Institute, Research Triangle Park, NC
RWE	Rheinisch-Westfaelisches Elektrizitaetswerk AG (Federal Republic of Germany
RWMC	Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho Falls, ID
S&L	Sargent and Lundy
S&W	Stone and Webster Engineering Corporation
SA	specific activity
SAEOS	see EOS
SAFSTOR	safe storage option followed by deferred decontamination
SAI	Science Applications, Inc.
SAPS	Shippingport Atomic Power Station, Shippingport, PA
SAR	safety analysis report
SCA	single-channel analyzer
SCK	Studiecentrum voor Kernenergie (part of CEEN)
SCNEDR	Societe Cooperative Nationale pour l'Entreposage de Dechtets Radioactifs (Switzerland)
SCPRI	Service Central de Protection Contre les Rayonnements Ionisants, Le Vesinet, France
SEAB	Studsvik Energiteknik AB, Nykoping, Sweden
SEB	Source Evaluation Board
SEFOR	Southwest Experimental Fast Oxide Reactor, Fayetteville, AR
SEFR	Shielding Experiment Facility Reactor
SEM	scanning electron microscopy
SER	safety evaluation report

SETCCI	Societe Europeenne paur le Traitement Chimique des Combustibles Irradies, Mol, Belgium
SFMP	Surplus Facilities Management Program, U.S. Department of Energy
SFMPO	Surplus Facilities Management Program Office, U.S. Department of Energy, Richland Operations Office, Richland, WA
SFO	San Francisco Operations Office, U.S. Department of Energy, Oakland, CA
SFOE	Swiss Federal Office of Energy, Wurenlingen, Switzerland (see HSK)
SISA	Siege S ›cial, Paris, France
SKA	Studienkommission fur Atomenergie (Switzerland)
SKAB	Svensk Kaernbraenslefoersoerjning AB, Stockholm, Sweden
SKBF	see SKAB and SNFSC
SKI	Statens Kaernkraftinspektion (Sweden)
SLAC	Stanford Linear Accelerator Center (California)
SLAPS	St. Louis Airport Site, St. Louis, MO
SLB	shallow land burial
SLCRC	Salt Lake City Research Center, U.S. Bureau of Mines, Salt Lake City, UT
SM	special metallurgical
SMDC	Saskatchewan Mining Development Corporation, Saskatoon, Saskatchewan, Canada
SMUD	Sacramento Municipal Utility District, Sacramento, CA
SNAP	Systems for Nuclear Auxiliary Power (space applications)
SNEC	Saxton Nuclear Experimental Corporation (Pennsylvania)
SNFSC	Swedish Nuclear Fuel Supply Company, Stockholm, Sweden(see SKAB and SKBF)
SNGS	Salem Nuclear Generating Station, Salem, NJ
SNL	Sandia National Laboratories, Albuquerque, NM
SNLA	Sandia National Laboratories - Albuquerque, Albuquerque, NM
SNLL	Sandia National Laboratories - Livermore, Livermore, CA
SNM	special nuclear materials
SNPP	Skagit Nuclear Power Project, Sedro Woolley, WA
SNPS	Saxton Nuclear Power Station, Saxton, PA
SNPS	Shoreham Nuclear Power Station, Brookhaven, NY
SNRO	Schenectady Naval Reactors Office, U.S. Department of Energy, Schenectady, NY
SNS	Seabrook Nuclear Station, Seabrook, NH
SONGS	San Onofre Nuclear Generating Station, San Clemente, CA
SPAC	surface plasma arc cutting
SPERT	Special Power Excursion Reactor Test, Idaho National Engineering Laboratory, Idaho Falls, ID
SRDC	Stieff Research and Development Company
SRE	Sodium Reactor Experiment, Santa Susana Field Laboratories, Canoga Park, CA
SRI	Stanford Research Institute, Menlo Park, CA
SRK	Steffen, Robertson and Kirsten, Inc.
SRL	Savannah River Laboratory, Aiken, SC
SRO	Savannah River Operations Office, U.S. Department of Energy, Aiken, SC
SRP	Savannah River Plant, Aiken, SC
SS	stainless steel
SSDP	Shippingport Station Decommissioning Project
SSES	Susquehanna Steam Electric Station, Berwick, PA
SSFL	Santa Susana Field Laboratories, Rockwell International, Atomics International Division, Canoga Park, CA

SSIE	Smithsonian Science Information Exchange, Washington, DC
STF	Statens Tekniska Forskningscentral (Finland) (see VTT)
STIR	Shield Test Irradiation Reactor, Santa Susana, CA
STMI	Service Technique Mistere Industrie (France)
STP	standard temperature and pressure
STT	Shielded Transfer Tanks, Oak Ridge National Laboratory, Oak Ridge, TN
SUNY	State University of New York
SWEC	Stone and Webster Engineering Corporation
SWRA	see WRA
TAC	Technology Application Center (University of New Mexico)
TAC	technical assistance contractor
TAN	Test Area North, Idaho National Engineering Laboratory, Idaho Falls, ID
TDS	Technical Services Division, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN
TEC	Technology for Energy Corporation, Oak Ridge, TN
TEC	total estimated cost
TES	Teledyne Energy Systems
TIC	Technical Information Center, U.S. Department of Energy, Oak Ridge, TN
TLD	thermoluminescent dosimeter
TMC	Technical Measurements Center, Bendix Field Engineering Corporation, Grand Junction, CO
TMI	Three Mile Island Nuclear Power Station, Middletown, PA
TMI-2	Three Mile Island Nuclear Power Station, Unit-2, Middletown, PA
TMISP	see TMI
TNP	Trojan Nuclear Plant, Prescott, OR
TOLED	Toledo Edison Company
TRCF	Technical Research Centre of Finland
TRIGA	Training Reactor-Isotope Production-General Atomics (reactor design)
TRU	transuranic
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility, Nevada Test Site, Mercury, NV
TSR	Tower Shielding Reactor, Oak Ridge National Laboratory, Oak Ridge, TN
TTG	Termomeccanica-nucleare e Turbogas, Fiat, Torino, Italy
TUV	Technischer Uberwachungs-Verein (Federal Republic of Germany)
TVA	Tennessee Valley Authority
UBC	uniform building code
UCCL	Union Carbide Canada Limited, Toronto, Ontario, Canada
UCCLD	Union Carbide Corporation, Linde Division
UCCND	Union Carbide Corporation, Nuclear Division, Oak Ridge, TN
UCI	Uranium Corporation of India, Singhbhum, Bihar, India
UCLR	University of California, Lawrence Radiation Laboratory
UEC	United Engineers and Constructors, Inc.
UHTREX	Ultra High Temperature Reactor Experiment, Los Alamos National Laboratory, Los Alamos, NM
UK	United Kingdom
UKAEA	United Kingdom Atomic Energy Authority
UMTRA	Uranium Mill Tailings Remedial Action (project office for UMTRAP)
UMTRAP	Uranium Mill Tailings Remedial Action Program, U.S. Department of Energy
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
UNC	UNC Nuclear Industries, Inc., Richland, WA (also United Nuclear Corporation)

UNCNI	see UNC
UNI	United Nuclear Industries
UOR	unusual occurrence report
USAEC	U.S. Atomic Energy Commission, Washington, DC (predecessor of ERDA)
USBOM	U.S. Bureau of Mines, Washington, DC
USDOE	U.S. Department of Energy, Washington, DC
USEPA	U.S. Environmental Protection Agency, Washington, DC
USERDA	U.S. Energy Research and Development Administration, Washington, DC (predecessor of DOE)
USGAO	U.S. General Accounting Office, Washington, DC
USNRC	U.S. Nuclear Regulatory Commission, Washington, DC
USPB	Urusan Seri Paduka Baginda (Malaysia)
USSR	Union of Soviet Socialist Republics
VAK	Kahl Nuclear Power Plant (Federal Republic of Germany)
VBWR	Vallecitos Boiling Water Reactor, Pleasanton, CA
VDEW	Vereinigung Deutscher Elektrizitatswerke E.V., Frankfurt, Federal Republic of Germany
VDEW	West German Association of Power Stations (translated from German)
VEBR	Virginia Experimental Boiling Reactor
VEPCO	Virginia Electric Power Company
VESR	Vallecitos Experimental Superheat Reactor, Pleasanton, CA
VNC	Vallecitos Nuclear Center, Vallecitos, CA (General Electric Company)
VRMP	Vitro Rare Metals Plant, Canonsburg, PA
VTT	Valtion Teknillinen Tutkimuskeskus (Finland) (see STF)
VYNPC	Vermont Yankee Nuclear Power Corporation
VYNPS	Vermont Yankee Nuclear Power Station, Vernon, VT
WAESD	Westinghouse Advanced Energy Systems Division (formerly WARD)
WAGR	Windscale Advanced Gas-cooled Reactor (United Kingdom)
WAHE	Water-Air Heat Exchanger, Oak Ridge National Laboratory, Oak Ridge, TN
WANL	Westinghouse Astronuclear Laboratory, Pittsburgh, PA
WAPD	Westinghouse Atomic Power Division
WARD	Westinghouse Advanced Reactor Division (now WAESD)
WARDFL	Westinghouse Advanced Reactor Division Fuel Laboratories, Cheswick, PA
WBNS	Water Boiler Neutron Source, Santa Susana Field Laboratories, Canoga Park, CA
WBS	work breakdown schedule
WDF	Waste Dismantling Facility
WEC	Westinghouse Electric Corporation
WEF	Waste Evaporator Facility, Oak Ridge National Laboratory, Oak Ridge, TN
WHB	Waste Holding Basin, Oak Ridge National Laboratory, Oak Ridge, TN
WHC	Westinghouse Hanford Company, Richland, WA
WIPP	Waste Isolation Pilot Plant (New Mexico)
WL	working level
WLL	West Lake Landfill, St. Louis, MO
WNPDL	Windscale Nuclear Power Development Laboratories, United Kingdom Atomic Energy Authority, Sellafield, United Kingdom
WNRE	Whiteshell Nuclear Research Establishment, Atomic Energy of Canada Limited, Pinawa, Manitoba, Canada
WNYNSC	Western New York Nuclear Service Center, West Valley, NY
WPAFB	Wright-Patterson Air Force Base (Ohio)
WPPSS	Washington Public Power Supply System, Richland, WA
WRA	Water Resources Abstracts

WSCP	Weldon Spring Chemical Plant, Weldon Spring, MO
WSQ	Weldon Spring Quarry, Weldon Spring, MO
WSS	Weldon Spring Site, Weldon Spring, MO
WTR	Westinghouse Testing Reactor, Waltz Mill, PA
WVDA	West Valley Demonstration Act (1980)
WVNSC	West Valley Nuclear Services Company, Inc., West Valley, NY
X-10	former site designation of Oak Ridge National Laboratory
Y-12	Y-12 Plant, Oak Ridge, TN
YCNP	Yellow Creek Nuclear Plant, Corinth, MS
YNPS	Yankee Nuclear Power Station, Rowe, MA
ZNP	Zion Nuclear Plant, Zion, IL

APPENDIX

Acronyms and Abbreviations

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52-350. Remedial Action Program Information Center
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