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MARTIN MARIETTA

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# ENVIRONMENTAL RESTORATION PROGRAM

# Nuclear Facility Decommissioning and Site Remedial Actions: A Selected Bibliography, Vol. 12

ENERGY SYSTEMS

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY
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Remedial Action Program Information Center

# Nuclear Facility Decommissioning and Site Remedial Actions: A Selected Bibliography, Vol. 12


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MARTIN MARIETTA ENERGY SYSTEMS, INC.
managing the
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Oak Ridge Y-12 Plant
Oak Ridge K-25 Site
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Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-76OR00001
for the
U.S. DEPARTMENT OF ENERGY

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# ABSTRACT

The 664 abstracted references on environmental restoration, nuclear facility decommissioning, uranium mill tailings management, and site remedial actions constitute the twelfth in a series of reports prepared annually for the U.S. Department of Energy Remedial Action Programs. Citations to foreign and domestic literature of all types—technical reports, progress reports, journal articles, symposia proceedings, theses, books, patents, legislation, and research project descriptions—have been included. The bibliography contains scientific, technical, economic, regulatory, and legal information pertinent to the U.S. Department of Energy Remedial Action Programs. Major sections are (1) Decontamination and Decommissioning Program, (2) Nuclear Facilities Decommissioning, (3) Formerly Utilized Sites Remedial Action Program, (4) Facilities Contaminated with Naturally Occurring Radionuclides, (5) Uranium Mill Tailings Remedial Action Program, (6) Uranium Mill Tailings Management, (7) Technical Measurements Center, and (8) Environmental Restoration Program. Within these categories, references are arranged alphabetically by first author. Those references having no individual author are listed by corporate affiliation or by publication title. Indexes are provided for author, corporate affiliation, title word, publication description, geographic location, subject category, and key word.

This report is a product of the Remedial Action Program Information Center (RAPIC), which selects, analyzes, and disseminates information on environmental restoration and remedial actions. RAPIC staff and resources are available to meet a variety of information needs. Contact the center at FTS 624-7764 or (615) 574-7764.

# INTRODUCTION

The Remedial Action Program Information Center (RAPIC) is funded by the U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management to provide technical information support to DOE remedial action programs under the direct sponsorship of the following:

- Decontamination and Decommissioning Program

  Lead Office—DOE Headquarters

  Lead Technical Contractor—Office of Technical Services
  - Weston (Roy F.), Inc.
  - H&R Technical Associates, Inc.

- Formerly Utilized Sites Remedial Action Program

  Lead Office—DOE Field Office, Oak Ridge

  Lead Technical Contractor—Bechtel National, Inc.

- Uranium Mill Tailings Remedial Action Program

  Lead Office—DOE Field Office, Albuquerque

  Lead Technical Contractor—Jacobs Engineering Group, Inc.

RAPIC, which is part of the Information Systems department, Environmental Restoration Division, Martin Marietta Energy Systems, Inc., serves as an information resource for scientific, regulatory, and socioeconomic aspects of radioactively contaminated facility and site remedial actions. These remedial actions encompass such activities as

- Performing characterization surveys of radioactively contaminated facilities and sites,
- Conducting ongoing security and surveillance programs,
- Performing preventive maintenance actions to ensure containment of radioactivity 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 and sites available for restricted or unrestricted use.

These 664 abstracted references constitute the twelfth annual publication of the same title and subject coverage. The contents of this publication are stored in a comprehensive, computer-retrievable data file that undergoes periodic updating. Most researchers use the published bibliographies as their "first-line" reference tool; however, the cumulative data file can be accessed through RAPIC for the most current additions or for a comprehensive search.

**Subject Coverage**

The subject matter of this bibliography is presented in eight sections: Decontamination and Decommissioning Program, Nuclear Facilities Decommissioning, Formerly Utilized Sites Remedial Action Program, Facilities Contaminated with Natural Radioactivity, Uranium Mill Tailings Remedial Action Program, Uranium Mill Tailings Management, Technical Measurements Center, and Environmental Restoration Program.

The Decontamination and Decommissioning (D&D) Program section contains references pertaining to the DOE program, program sites (located primarily on federal reservations), and specific D&D technology developed by the program.

The Nuclear Facilities Decommissioning section presents foreign D&D information as well as any D&D technology and domestic site-specific information that is not a part of the DOE program.

The Formerly Utilized Sites Remedial Action Program (FUSRAP) section lists publications 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 section 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 (UMTRA) Program section contains information pertinent to UMTRA management or to the 24 UMTRA sites, located primarily in the western United States. These sites are inactive uranium mill sites that were operated under government contract.

The section 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 (TMC) section lists reports published by TMC, Grand Junction, Colorado, on the subject of detection and measurement of radioactive/hazardous contaminants, instrument calibration, and field calibration facilities.

The Environmental Restoration Program section contains references pertinent to activities conducted and plans prepared by the DOE Office of Environmental Restoration.

## Indexes

The color-coded indexes are a quick guide to finding needed information. The numbers appearing after each listing in the indexes are citation numbers. The author index (pink pages) lists all authors for each citation. The corporate affiliation index (blue pages) is an alphabetical listing of the institution performing the work. The title word index (yellow pages) provides a permuted index of all major words in each title (except such pervasive words as *decommissioning, decontamination, tailings, etc.*). The publication description index (green pages) lists alphabetically all journal names, conference descriptions, report numbers, or other unique document descriptions that would identify the publication. The title of the document is listed below each entry in the publication description index. The geographic location index (gold pages) provides an alphabetical listing of the geographic descriptions of sites referenced in the bibliography; these are divided into domestic sites and foreign sites. A subject category index (white pages) is provided for the sections. The subject categories are: 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 key word index (buff pages) is an alphabetical index of terms selected from a controlled thesaurus to characterize specific concepts.

## Citation Form

The references within each section are arranged alphabetically by first author, corporate affiliation, or publication description of the document. When an 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, but the citation is integrated into the section by the alphabetical position of its publication description.

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 are shown as, for example, 6 cu cm for 6 cubic centimeters or 3 sq km for 3 square kilometers.
5. 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 | ($10^{18}$) |

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 | megaelectronvolt |
| 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 | kiloelectron volt | yr | year |

## Services

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.

RAPIC provides information support to a large number of researchers involved in the fields of remedial action and radioactive waste management. Certain services such as providing information from RAPIC resources, performing literature searches of computerized data bases, and providing assistance in locating hardcopies of documents referenced in the bibliography are provided free of charge to the DOE Remedial Action Program staff and their subcontractors. All inquiries for information services should be addressed to:

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FAX: *Send FTS 626-6547, 615/576-6547*

Telex: *854511 (ORNL IRA-HMI)*

## Acknowledgments

The authors wish to acknowledge John K. Williams, Romance Carrier, and Richard Swaja of the Health and Safety Research Division for time spent reviewing this report.

## SAMPLE REFERENCE

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

*1 — Page Number*
*2 — Chapter 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*

[1]*131* **_Nuclear Facilities Decommissioning_**[2]

[3]**191**
[4]R.C. Anderson 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.

# DECONTAMINATION AND DECOMMISSIONING PROGRAM

1

R.P. Allen and A.B. Johnson Jr., Pacific Northwest Laboratory, Richland, WA

**Lessons Learned to Date from the Shippingport Aging Evaluation**

CONF-8810155; Proceedings of the 16th Water Reactor Safety Information Meeting, Gaithersburg, MD, October 24-27, 1988; Nuclear Engineering and Design 118(3):319-327 (April 1990)

More than 200 naturally aged components and samples, ranging in size from small instruments and metallurgical specimens to one of the main coolant pumps, have been removed in conjunction with the decommissioning of the Shippingport Atomic Power Station and shipped to designated U.S. Nuclear Regulatory Commission (NRC) contractors. In situ assessments of selected Shippingport Station systems and components have also been conducted. Although the detailed evaluation of the naturally aged components and materials from the Shippingport Station is just beginning, there are a number of preliminary studies and results that are indicative of the value of the aging information that ultimately will be obtained. This paper presents background information on the Shippingport Station and its history, discusses the selection and relevancy of the naturally aged components and materials obtained through the NRC Nuclear Plant Aging Research program, and illustrates the type of important plant-aging information that can be derived from the in situ studies and from detailed evaluations of the components and samples from the Shippingport Station.

2

R.J. Arthur and D.L. Haggard, Pacific Northwest Laboratory, Richland, WA

**In-Situ Determination of Radionuclide Levels in Facilities to be Decommissioned Using the Allowable Residual Contamination Level Method**

PNL-6974; 105 pp. (July 1989)

This feasibility study resulted in verification of one direct and two alternate indirect techniques for making in situ determinations of Sr-90 and other radionuclide levels in a Hanford facility to be decommissioned. The facility was evaluated using the Allowable Residual Contamination Level (ARCL) method. The ARCL method is used to determine the extent of decontamination that will be required before a facility can be decommissioned. A sump in Building 1608F was chosen for the feasibility study. Hanford decommissioning personnel had previously taken 79 concrete and surface-scale samples from the building to be analyzed by radiochemical analysis. The results of the radiochemical analyses compare favorably with the values derived by the in situ methods presented in this report. Results obtained using a portable spectrometer and thermoluminescent dosimeters (TLDs) were both very close to the radiochemistry results. Surface Sr-90 levels detected on the sump floor were 550 pCi/sq cm using the spectrometer system and 780 pCi/sq cm using the TLD data. This compares favorably with the levels determined by radiochemical analyses (i.e., 230 to 730 pCi/sq cm). Surface Sr-90 levels detected on the sump wall ranged between 10 and 80 pCi/sq cm using the spectrometer system, compared with a conservative 200 pCi/sq cm using the TLD data. The radiochemical results ranged between 19 and 77 pCi/sq cm for the

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W.R. Beaver, Carnegie Mellon University, Pittsburgh, PA

**Shippingport: Nuclear Power Comes to the Utilities**

Dissertation Abstracts International 47(05-A):1785-2001 (1985)

The Shippingport Atomic Power Station marked the first attempt by the federal government to promote civilian nuclear power in conjunction with a private utility (Duquesne Light of Pittsburgh). Although the electric utilities had always shown a willingness to develop new technology, the uncertainties associated with this new technology were great. Thus, the Atomic Energy Commission (AEC) found it necessary to fund 90% of the project. In the past, holding companies had often financed large-scale technological innovation. But with Shippingport, the government financed the project and also supplied technological and managerial expertise. To supervise the project, the AEC chose Naval Reactors under the direction of Admiral Rickover. Rickover emphasized tight, centralized control over plant operations, using stringent procedures, effective training, and sound planning. The successful operation of the plant can be traced to the government's willingness to both provide the necessary expertise and to fund the project as required. In addition, Duquesne Light provided some of its best young employees to operate the plant. The relationship between Duquesne Light and Naval Reactors was at times difficult, largely because of the "intervening style" employed with its contractors. Nevertheless, differences did not interfere with the satisfactory outcome of plant operations, as both sides desired to see the project work. For Duquesne Light, Shippingport fit well into the company's power system and also provided positive publicity. On the negative side, the plant became the center of controversy because of alleged environmental contamination. In addition, the Shippingport experience appears to have had little benefit in helping the company operate the Beaver Valley I nuclear plant. Although Shippingport never demonstrated the economic viability of nuclear power, it did satisfy the government's technical and political goals, helping America maintain its technological leadership in nuclear power. Unfortunately, a more logical sequential program was never developed to accommodate the zealous promotion of nuclear power by the government.

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Bechtel National, Inc., Oak Ridge, TN

### Niagara Falls Storage Site Environmental Report for Calendar Year 1989

DOE/OR/20722-264; 124 pp. (May 1990)

The environmental monitoring program, which began in 1981, was continued during 1989 at the Niagara Falls Storage Site (NFSS), a U.S. Department of Energy (DOE) surplus facility located in Niagara County, New York. NFSS is currently used for interim storage of radioactive residues, contaminated soils, and rubble. NFSS is a remnant of a former Manhattan Engineer District/Atomic Energy Commission site used mostly (from 1944 to the present) for storing radioactive residues produced as by-products of uranium production. Remedial action at the site and vicinity properties was carried out from 1981 to 1986. All contaminated remediated materials are stored in the interim waste containment facility on the site. The environmental monitoring program is being conducted by Bechtel National, Inc. The monitoring program at NFSS measures radon concentrations in air; external gamma radiation levels; and uranium and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater samples. The radiation dose was calculated for a hypothetical, maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the conservative scenario described in this report, this hypothetical individual receives an annual external exposure approximately equivalent to 2% of the DOE radiation protection standard. The cumulative dose to the population within an 80 kilometer (50 mile) radius of NFSS which results from radioactive materials at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources. Results of the 1989 monitoring show that NFSS is in compliance with applicable DOE radiation protection standards.

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D.L. Becker, Rockwell Hanford Operations, Energy Systems Group, Richland, WA

### Evaluation of West Valley Neutralized Waste Tank Photographic, Video Television and Ultrasonic Measurement Inspection Records

RHO-RE-ST-8-P; 159 pp. (June 1983)

The nuclear fuel reprocessing operations conducted at the Western New York State Nuclear Service Center, West Valley, New York, between 1966 and 1972 produced approximately 572,000 gal of high-level liquid waste which is presently being stored in underground tanks. The Nuclear Regulatory Commission (NRC) in concurrence with the U.S. Department of Energy contracted with Rockwell Hanford Operations to obtain photographic, video television, and ultrasonic inspection records of two underground carbon steel tanks, Tanks 8D-1 and 8D-2. The result of an evaluation of these photographic, video, and ultrasonic inspections are contained in this report. Also provided is a description of the methods used, the inspection procedures, the inspection equipment and operation, and the evaluation processes. All work was completed by November 30, 1983, as agreed. The report is given in this document as an attachment to Rockwell Hanford responses to comments on the draft report made by reviewers at the NRC. The Rockwell Hanford responses are divided into two categories: (1) an attachment answering six questions from the NRC and (2) pages 17a and 17c, containing an expanded discussion of a comparison of tank-corrosion results experienced at Hanford and how these results might be extrapolated to West Valley storage tanks.

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J.L. Bognar, Jacobs Engineering Group, Inc., St. Charles, MO

**Permeability of the Multilayer Overburden System at the Weldon Spring Site**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 245-276) (February 1991)

Ample geologic and geotechnical data and very conservative assumptions were brought together to construct a conceptual model of the overburden at the Weldon Spring site disposal facility area study. Using this methodology, calculations to determine permeability of this model indicate that the naturally occurring materials are sufficiently impermeable to surpass minimum state standards for locating a disposal facility.

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L.E. Boing, Argonne National Laboratory, Argonne, IL

**Status Report on the Experimental Boiling Water Reactor (EBWR) Decontamination and Decommissioning (D&D) Project**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (26 pp.) (June 1991)

The Experimental Boiling Water Reactor operated from 1956 to 1967 at power levels ranging from 20 to 100 MW. At the time of plant shutdown, the reactor fuel was removed and the facility placed in dry lay-up. Decontamination and decommissioning (D&D) funding is being provided through the U.S. Department of Energy Surplus Facilities Management Program to clean up the facility to nonrestricted use levels. The D&D project was started in FY 1986 and is targeted for completion in FY 1995. This paper deals with the work completed, under way, and planned for the future. The different waste types generated to date on the project and waste handling techniques at Argonne National Laboratory are also described.

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L.E. Boing, D.R. Henley, W.J. Manion, and J.W. Gordon, Argonne National Laboratory, Argonne, IL; Nuclear Energy Services, Danbury, CT

**An Evaluation of Alternative Reactor Vessel Cutting Technologies for the Experimental Boiling Water Reactor at Argonne National Laboratory**

ANL-89/31; 167 pp. (December 1989)

Metal cutting techniques that can be used to segment the reactor pressure vessel of the Experimental Boiling-Water Reactor (EBWR) at Argonne National Laboratory (ANL) have been evaluated by Nuclear Energy Services. Twelve cutting technologies are described in terms of their ability to perform the required task, their performance characteristics, environmental and radiological impacts, and cost and schedule considerations. Specific recommendations regarding which technology should ultimately be used by ANL are included. The selection of a cutting method was the responsibility of the decommissioning staff at ANL, who included a relative weighing of the parameters described in this document in their evaluation process. A table in the Executive Summary lists the cutting technologies analyzed and the key parameters of each. This synopsis permits a rapid comparison of the techniques. For each metal-cutting technique, the cutting speed in a single pass for 2.5 in. thick steel is based on vendor information. Auxiliary systems that would be required to support the cutting system are listed. Additional development required before the system can be used to cut the EBWR vessel is noted. Costs are broken down into three capital components (cutting system, manipulator and viewing, and contaminant control) and consumables. In addition, particular limitations or shortcomings of a cutting technique are noted. Manipulator systems are assumed to be designed for cutting from inside the vessel; some cost savings may be realized by cutting from the outside.

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L.E. Boing, E.A. Wimunc, and G.A. Whittington, Argonne National Laboratory, Argonne, IL

**Design-Development and Operation of the Experimental Boiling-Water Reactor (EBWR) Facility - 1955-1967**

ANL-91/13; 25 pp. (November 1990)

The Experimental Boiling-Water Reactor (EBWR) was designed, built, and operated to provide experience and engineering data that would demonstrate the feasibility of the direct-cycle, boiling-water reactor and be applicable to improved, larger nuclear power stations; and was based on information obtained in the first test boiling-water reactors, the BORAX series. EBWR initially produced 20 MW(t), 5 MW(e); later modified and upgraded, as described and illustrated, it was operated at up to 100 MW(t). The facility fulfilled its primary mission - demonstrating the practicality of the direct-boiling concept - and, in fact, was the prototype of some of the first commercial plants and of reactor programs in some other countries. After successful completion of the Water-Cooled Reactor Program, EBWR was utilized in the joint Argonne-Hanford Plutonium Recycle Program to develop data for the utilization of plutonium as a fuel in light-water thermal systems. Final shutdown of the EBWR facility followed the termination of the latter program.

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R.D. Bundy and E.B. Munday, Oak Ridge National Laboratory, Oak Ridge, TN

**Investigation of Gas-Phase Decontamination of Internally Radioactively Contaminated Gaseous Diffusion Process Equipment and Piping**

CONF-910659; Proceedings of the 1991 Annual Meeting and Exhibition of the Air and Waste Management Association, Vancouver, Canada, June 16-21, 1991; (4 pp.) (1991)

Construction of the gaseous diffusion plants (GDPs) was begun during World War II to produce enriched uranium for defense purposes. These plants, which utilized UF6 gas, were used primarily for this purpose through 1964. From 1959 through 1968 production shifted primarily to uranium enrichment to supply the nuclear power industry. Additional UF6 handling facilities were built in feed and fuel-processing plants associated with the uranium enrichment process. Two of the five process buildings at Oak Ridge were shut down in 1964. Uranium enrichment activities at Oak Ridge were discontinued altogether in 1985. In 1987, the Department of Energy (DOE) decided to proceed with a permanent shutdown of the Oak Ridge Gaseous Diffusion Plant (ORGDP). DOE intends to begin decommissioning and decontamination of ORGDP early in the next century. The remaining two GDPs are expected to be shut down during the next 10 to 40 years and will also require decontamination and decommissioning, as will the other UF6 handling facilities. This paper presents an investigation of gas-phase decontamination of internally radioactively contaminated gaseous diffusion process equipment and piping using powerful fluorinating reagents that convert nonvolatile uranium compounds to volatile UF6. These reagents include ClF3, F-2, and other compounds.

The scope of decommissioning and decontamination at the GDPs, previous work of gas-phase decontamination, four concepts for using gas-phase decontamination, plans for further study of gas-phase decontamination and the current status of this work are discussed.

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T.R. Cannon, M.K. Ford, and L. Holder Jr., Oak Ridge National Laboratory, Environmental Restoration Division, Oak Ridge, TN

**Semiannual Summary Report on Surveillance and Maintenance Activities of the Surplus Contaminated Facilities Program at Oak Ridge National Laboratory for the Period Ending March 31, 1991**

ORNL/ER-34; 10 pp. (April 1991)

The Surplus Contaminated Facilities Program (SCFP) was established at Oak Ridge National Laboratory in 1985 to provide support for inactive, contaminated facilities that were largely abandoned by the programs they formerly served. This support provides for routine surveillance and maintenance and special projects beyond a routine nature when such actions are needed to ensure adequate protection of personnel or the environment. The facilities included in the program had been used for research, technology development, isotope production and processing, and waste management. Support for facilities in the SCFP has previously been provided by the DOE Office of Energy Research (Multiprogram Energy Laboratories - Facilities Support) because of multiprogram use of the facilities and because of the landlord responsibility of Energy Research. Recently, an integrated decontamination and decommissioning (D&D) program within the DOE Office of Environmental Restoration and Waste Management was established to collectively manage the former Surplus Facilities Management Program, Defense D&D Program, and the SCFP. This report gives an overview of the surveillance and maintenance planning, routine surveillance and maintenance, and special maintenance project activities that occurred at the SCFP facilities during the first half of FY 1991. Surveillance and maintenance activities will continue in FY 1991 in the three main task areas for those facilities that meet the D&D Program acceptance criteria. Routine surveillance and maintenance will continue as scheduled. Operations for the 3110 Filter House filter change and the 9419-1 Decontamination Facility cleanup will resume when approval for National Environmental Policy Act documentation is obtained. Filters will be changed at the High-Level Chemical Development Laboratory (4507).

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D.E. Carl and I.M. Leonard, West Valley Nuclear Services Company, Inc., West Valley, NY

**Selection of the Treatment Method for the West Valley Alkaline Supernatant**

DOE/NE-44139-25; 105 pp. (February 1987)

As part of the West Valley Demonstration Project (WVDP), the PUREX supernatant stored in Tank 82-D will be partly decontaminated before encapsulation in the final glass form. This report discusses selection of a method for removing Cs-137, the major radioactive ion in the supernatant. Methods considered were (1) electrodialysis; (2) hyperfiltration; (3) precipitation with ferrocyanide, NaTPB, or PTA; (4) organic ion exchange using Cs-100 or a biologically derived media; (5) chelation using DeVoe/Holbein compositions; and (6) inorganic ion exchange using Durasil, natural zeolites, IE-95, or IE-96 media. Several different methods of using inorganic ion exchange media were also reviewed, including (a) four columns with elution and (b) two, three, or four columns with elution. This report includes a discussion of the tests performed to evaluate the methods considered and the conclusions reached by the WVDP. The extensive engineering evaluation undertaken for the selection of this process resulted in the selection of the best available method for cesium separation at West Valley. After careful evaluation of experimental data with all process constraints taken into account, the inorganic ion exchange media IE-96 (Linde Ionsiv IE-96 synthetic zeolite) was chosen for WVDP cesium recovery. IE-96 was chosen for the following reasons: high sorption rate, a decontamination factor over 1000, excellent exchange capacity at WVDP conditions, compatibility with the glass formers used for borosilicate glass in direct melter feed applications, and a history of successful application in radiochemical separation for waste streams. Attached to this report is a 2-page history of Storage Tank 8D-1, a spare tank to receive high-level waste from Tank 8D-2.

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J. Carman, Jacobs Engineering Group, Inc., St. Charles, MO

**Aquifer Characteristics of the Shallow Burlington-Keokuk Limestone at the Weldon Spring Site**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 155-202) (February 1991)

Slug tests, pumping tests, and tracer tests were conducted on the shallow bedrock aquifer at the Weldon Spring site to determine its hydraulic characteristics. Higher-than-average hydraulic conductivity values from slug tests in certain wells indicate that discreet flow occurs. Pumping tests in the upper part of the aquifer indicate a primary lateral anisotropy and poor hydraulic communication between pumped intervals and deeper portions of the formation. Tracer tests produced effective porosity values of 0.002 to 0.015. Calculated groundwater velocities and travel times appear to be consistent with observed contaminant distribution. The aquifer can be described in terms of unconfined diffuse Darcian flow overlain by high porosity discrete flow zones and conduits.

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O.K. Chopra, Argonne National Laboratory, Argonne, IL

**Studies of Aged Cast Stainless Steel from the Shippingport Reactor**

CONF-9010185; Proceedings of the 18th Water Reactor Safety Information Meeting, Gaithersburg, MD, October 22-24, 1989; 19 pp. (October 1990)

Charpy-impact and tensile tests were conducted on several cast stainless steel materials from the Shippingport reactor. Baseline mechanical properties for unaged material were determined from tests on either recovery-annealed material, i.e., material annealed for 1 h at 550 deg C and water-quenched, or on material from the cooler region of the component. The materials indicate relatively modest decreases in impact energy. The results show good agreement with estimations based on accelerated laboratory-aging studies. Correlations for estimating thermal-aging degradation of cast stainless steels indicate that the degree of embrittlement of the Shippingport materials is low. The minimum room-temperature impact energies that would ever be achieved after long-term aging are greater than 75 J/cm(E+2) (greater than 45 ft/lb) for all materials. The estimated activation energies for embrittlement range from 150 to 230 kJ/mole. The estimated fracture toughness J-R curves for the materials are also presented.

15

J.W. Darby and J.A. Blanke, Bechtel National, Inc., Oak Ridge, TN

**Instrumented Waste Containment Test Cell**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 297-306) (April 1990)

At the Niagara Falls Storage Site in New York, a waste-storage-cell model was constructed to measure instrument response to the introduction of water into the cell, simulating cap failure. The measurements were made to demonstrate the usefulness of internal instrumentation for a waste cell in determining the location of a cap failure and in detecting the accumulations of water within the cell before sufficient water accumulated and discharge from the cell could occur. With the usual cell failure detection system, monitoring wells only show cell failure after contaminants are outside the cell. The internal system gives warning before the discharge occurs. The test cell provides real values for comparison to calculated values for water accumulation.

16

J.S. Devgun, Argonne National Laboratory, Argonne, IL

**Environmental Impact Assessment for a Radioactive Waste Facility: A Case Study**

CONF-9006270; Proceedings of the IAIA '90 Conference, Lausanne, Switzerland, June 26-30, 1990; (25 pp.) (1990)

A 77-ha site, known as the Niagara Falls Storage Site, located in northwestern New York State, holds about 190,000 sq m of soils, wastes, and residues contaminated with radium and uranium. The facility is owned by the U.S. Department of Energy. The storage of residues resulting from the processing of uranium ores started in 1944; by 1950 residues from a number of plants were received at the site. The residues, with a volume of about 18,000 sq m, account for the bulk of the radioactivity, which is primarily due to the presence of Ra-226; because of the extraction of uranium from the ore, the amount of uranium remaining in the residues is quite small. The environmental impact assessment and environmental compliance actions taken to date at this site are analyzed and their effectiveness discussed. This case study provides an illustrative example of the complexity of technical and nontechnical issues for a large radiative waste facility.

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J.S. Devgun, N.J. Beskid, W.M. Seay, and E. McNamee, Argonne National Laboratory, Argonne, IL; U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN; Bechtel National, Inc., Oak Ridge, TN

**Effectiveness of Interim Remedial Actions at the Niagara Falls Storage Site**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 125-131) (1990)

There are 190,000 cu m of contaminated soils, wastes, and residues stored at the Niagara Falls Storage Site (NFSS). The residues have a volume of 18,000 cubic meters and contain about 1930 Ci of Ra-226, which accounts for most of the radioactivity. Since 1980, actions have been taken to minimize potential radiological risks and prevent radionuclide migration. Interim actions included capping vents, sealing pipes, relocating the perimeter fence (to limit radon risk), transferring and consolidating wastes, upgrading storage buildings, constructing a clay cutoff wall (to limit potential groundwater transport of contaminants), treating and releasing contaminated water, using a synthetic liner, and using an interim clay cap. An interim waste containment facility was completed in 1986. Environmental monitoring showed a decrease in radon concentrations and in external gamma radiation from 1982 to 1986; levels have been stable since 1986. Uranium and radium concentrations in surface water have decreased; very low concentrations have been detected in stream sediments, and concentrations in groundwater have remained stable. Recent monitoring showed that NFSS is in compliance with U.S. Department of Energy radiation protection standards.

18

L.A. Durham, Argonne National Laboratory, Argonne, IL

**Groundwater Modeling at the Weldon Spring Chemical Plan/Raffinate Pits and Vicinity Properties**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 203-226) (February 1991)

A three-dimensional, finite-element computer model of groundwater flow in the Burlington-Keokuk aquifer was developed. Data came from studies by various organizations associated with the project. The model distinguishes between the characteristics of the weathered and competent units of the Burlington-Keokuk Limestone. Parameters for hydraulic conductivity and the hydraulic stress came from field tests. The model was calibrated by adjusting the aquifer properties to obtain the best match between computer-generated and observed data. The model validated the project's conceptual understanding of the aquifer. Possible future uses include analyzing the feasibility of site-wide groundwater remediation and addressing concerns about groundwater contamination that could result if an on-site disposal cell were to fail.

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M.K. Ford and L. Holder Jr., Oak Ridge National Laboratory, Environmental Restoration Division, Oak Ridge, TN

**Semiannual Summary Report of the Decontamination and Decommissioning Surveillance and Maintenance Program at Oak Ridge National Laboratory for Period Ending March 31, 1991**

ORNL/ER-32; 9 pp. (April 1991)

The Surplus Facilities Management Program and the Defense Facilities Decommissioning Program were established at Oak Ridge National Laboratory (ORNL) in 1976 to provide collective management of all surplus sites under ORNL control within the Oak Ridge Reservation. Some 34 facilities, classified into 3 civilian- and 8 defense-related projects, are currently managed by the recently integrated Decontamination and Decommissioning Program. Support includes (1) surveillance and maintenance planning, (2) routine surveillance and maintenance, and (3) special maintenance projects. This report documents routine surveillance and maintenance, special projects, and special maintenance performed on these facilities for the period between October 1990 through March 1991. Surveillance and maintenance activities will continue in FY 1991, and routine surveillance and maintenance will continue as scheduled. Asbestos abatement, repackaging of zinc bromide, sampling and analysis of the Homogeneous Reactor Experiment (HRE) and 3002 Filter House Canal pools, Occupational Safety and Health Act compliance upgrades at the Low Intensity Test Reactor and HRE, and repair of the Waste Evaporator roof will continue pending approval of National Environmental Policy Act documentation.

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M.K. Ford, L. Holder Jr., and R.G. Jones, Oak Ridge National Laboratory, Environmental Restoration Division, Oak Ridge, TN

**Semiannual Summary Report on Surveillance and Maintenance of Activities of Waste Area Groupings at Oak Ridge National Laboratory for Period Ending March 31, 1991**

ORNL/ER-33; 19 pp. (April 1991)

Surveillance and maintenance of 75 sites at Oak Ridge National Laboratory was conducted by the Remedial Action Section for the Environmental Restoration Program. This surveillance and maintenance function is performed at surplus facilities and sites contaminated with radioactive materials and/or hazardous chemicals, from the end of their operating life until final facility disposal or site stabilization. The waste area grouping surveillance and maintenance program objectives are met by maintaining a structure program of routine surveillance and maintenance, as well as implementing interim corrective maintenance when deemed necessary as a result of site surveillance. This report briefly presents this program's activities for the first half of FY 1991, including tables indicating tank levels and dry-well data. Surveillance and maintenance activities will continue in the main task areas described in the report during the remainder of FY 1991. Scoping surveys will continue to investigate sites about which additional information is needed. Routine surveillance and maintenance will continue as scheduled, and special projects will continue to correct serious site deficiencies that are beyond the scope of routine maintenance. These special projects will focus on isolation from human intrusion of additional areas containing contaminated vegetation and on surveillance instrumentation upgrades.

21

M. Forsbacka and M. Moore, Armed Forces Radiobiology Research Institute, Bethesda, MD

**Analysis of Decommissioning Costs for the AFRRI TRIGA Reactor Facility - Technical Report**

AD-A-221513/5; AFRRI-TR-89-2; 16 pp. (December 1989)

This report provides a cost analysis for decommissioning the Armed Forces Radiobiology Research Institute (AFRRI) TRIGA reactor facility. AFRRI is not suggesting that the AFRRI TRIGA reactor facility be decommissioned. This report was prepared in compliance with paragraph 50.33 of Title 10, Code of Federal Regulations, which requires that funding for the decommissioning of reactor facilities be available when licensed activities cease. The planned method of decommissioning is complete decontamination (DECON) of the AFRRI TRIGA reactor site to allow for restoration of the site to full public access. The cost of DECON in 1990 dollars is estimated to be $3,200,000. The anticipated ancillary costs of facility-site demobilization and spent-fuel shipment will be an additional $600,000. Thus, the total cost of terminating reactor operations at AFRRI will be about $3,800,000. The primary basis for developing this cost estimate was a study of the decommissioning costs of a similar reactor facility performed by Battelle Pacific Northwest Laboratory, as provided in U.S. Nuclear Regulatory Commission publication NUREG/CR-1756. The data in this study were adapted to reflect the decommissioning requirements of the AFRRI TRIGA reactor facility.

22

M. Garstang, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO

**Collapse Potential Evaluation of the Defined Study Area at the Weldon Spring Chemical Plant Site, Weldon Spring, Missouri**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 277-296) (February 1991)

Missouri regulations prohibit construction of hazardous waste landfills in areas that are prone to catastrophic collapse. Significant collapse potential would eliminate the proposed Weldon Spring on-site disposal area from further consideration. The Missouri Division of Geology and Land Survey (DGLS) evaluated the portion of the site designated for an on-site disposal area. In evaluating proposed waste disposal sites, the primary concern is for collapse or failure of the ground surface beneath the facility. Such a failure could allow contaminants to leak into the subsurface. DGLS evaluates surface hydrology, subsurface hydrology, predominant characteristics of the uppermost soil and rock, and the proximity of sinkholes or caves to proposed disposal. At the Weldon Spring site, DGLS helped gather data and oversee DOE exploratory drilling and pit exploration. The most important factor evaluated was the presence or absence of voids in the soil and the bedrock: voids were few and small, 90% of the void space was within the upper 10 ft of bedrock, and no void space was encountered in the overburden or soil material. No open subsurface networks, which could contribute to collapse, have been identified. All the drainages in the area of the chemical plant site area are classified as gaining. Dye trace tests suggest that voids are isolated. The nearest caves are about 5 miles from the study area. The nearest sinkhole is about 1 mile away. The state of Missouri has concluded that significant potential for catastrophic collapse does not exist in the currently defined 100-acre study area.

23

M. Gilbert, Jacobs Engineering Group, Inc., St. Charles, MO

**Introduction to the Geology of the Weldon Spring Site**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 17-40) (February 1991)

The Weldon Spring site is situated near the boundary between the Central Lowlands and the Ozark Plateau physiographic provinces. It is bisected by a topographic ridge dividing surface drainage to the Missouri and Mississippi River valleys. Surface slopes are generally gentle. The bedrock has a northwest regional strike and a shallow dip. The Cottleville Fault, with a vertical displacement of approximately 18.3 m (60 ft), is 1.6 km (1 mi) north of the site. The most important geological formation is the Burlington-Keokuk Limestone, consisting of two units, an upper weathered unit and a lower competent unit. The overburden in the area consists of unconsolidated materials in five units: (1) topsoil/fill, (2) loess, (3) the Ferrelview Formation (mostly glacial till-plain sediment), (4) glacial till (clay and basal), and (5) residuum from decomposition of underlying limestone.

24

W. Goldkamp, Jacobs Engineering Group, Inc., St. Charles, MO

**Containerized Chemical Consolidation and RCRA Compliance at the Weldon Spring Site Remedial Action Project**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 581-584) (April 1990)

The Weloon Spring Chemical Plant was operated by the Atomic Energy Commission as a uranium processing facility from 1957 to 1966. Nitric and hydrofluoric acids were used extensively, and other on-site tanks were used to store sulfuric acid, caustic soda solutions, propane, and hexane. A large quantity of organic and inorganic chemicals was abandoned in both process and nonprocess buildings. As part of the Comprehensive Environmental Response, Compensation, and Liability Act remedial action process, initial efforts to characterize the containerized chemicals took place beginning April 1987, when a project team searched each of the plant's 42 buildings. A chemical inventory was completed in May 1988. Fifty-five percent of a total 48,000 liters of unknown liquids and solids was judged likely to be Resource Conservation and Recovery Act hazardous; all material was potentially contaminated with uranium or uranium by-products. This report relates the subsequent work performed to consolidate, remove, and dispose of the containerized chemicals.

25

S. Grozescu, U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, MO

**Geotechnical Investigation at the Weldon Spring Site**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 235-246) (February 1991)

The U.S. Department of Energy and its subcontractors have conducted several geotechnical and geophysical investigations at the Weldon Spring site, mostly in 1988-90, to derive geotechnical design parameters for foundation design, evaluation of remedial action alternatives, assessment of dike stability, and identification of off-site borrow sources. Geotechnical investigations were designed to provide complete engineering parameters of the overburden soil materials, on their thickness and permeability, and on bedrock surface depths. An extensive geophysical survey refined the geological model of the site subsurface. Laboratory testing determined the engineering properties of overburden units.

26

A.H. Hadjian, Bechtel Power Corporation, Los Angeles, CA

**Model Testing Conducted to Benchmark the Shippingport Reactor Pressure Vessel/Neutron Shield Tank Package Safety Analysis**

CONF-890855 (Vol. J); Structural Mechanics in Reactor Technology (SMIRT): Extreme Loads Analysis, Proceedings of the Tenth International Conference, Anaheim, CA, August 14-18, 1989, Vol. J, 337 pp.; (pp. 115-120) (1989)

The decommissioned Shippingport reactor pressure vessel (RPV) and its integral neutron shield tank (NST) were transported for burial. The RPV/NST package is a monolithic structure of light-weight concrete and steel. A safety analysis report for packaging (SARP) was prepared. One tenth-size benchmark model representations of the RPV/NST package were drop-tested to confirm the predicted results and to provide experimental benchmark data to support the physical and mechanical properties of the material and the reaction rates used in the analyses. A series of 11 drop tests were conducted on seven models from heights of 30.5 cm (1 ft), 9.14 m (30 ft), and 13.7 m (45 ft). This paper briefly describes the benchmark drop test models and the specific drop tests conducted and presents a discussion of the technical evaluation and correlation of the test data to analytical results.

**27**

L.A. Haroun, J.M. Peterson, M.M. MacDonell, D.J. Fingleton, and S.H. McCracken, Argonne National Laboratory, Argonne, IL

**Risk Assessment at the Weldon Spring Site: Lessons Learned**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 331-354) (April 1990)

Several health-risk assessments have been prepared for the Weldon Spring Site Remedial Action Project, including (1) the quarry and site water treatment plant engineering evaluation/cost analyses; (2) the quarry baseline risk evaluation; (3) the quarry feasibility study; (4) the site baseline risk assessment; and (5) the site feasibility study. This presentation covers five general topics: (a) specific health risk assessments for the Weldon Spring Site, including their scope and methodology; (b) objectives of the health risk assessment; (c) lessons learned to date; (d) emerging issues in health risk assessment for U.S. Department of Energy Superfund sites; and (e) an ecological assessment.

**28**

W.F. Heine and D.R. Speer, Westinghouse Hanford Company, Richland, WA

**Decontamination and Decommissioning of a Fuel Reprocessing Pilot Plant**

WHC-SA-0256; 17 pp. (January 1988)

The Semiworks Pilot Fuel Reprocessing Plant for strontium at the Hanford site in Washington State was decommissioned by a combination of dismantling and entombment. The facility contained 9600 Ci of Sr-90 and 10 Ci of plutonium. Process cells were entombed in place. The above-grade portion of one cell with 1.5-m (5-ft)-thick walls and ceilings was demolished with expanding grout. A contaminated stack was remotely sandblasted and felled by explosives. The entombed structures were covered with a 4.6-m (15 ft)-thick engineered earthen barrier.

**29**

M.C. Hughes, G.W. Jackson, and J.D. Goodenough, Westinghouse Hanford Company, Richland, WA; U.S. Department of Energy, Richland Operations Office, Richland, WA

**Decommissioning of Surplus Facilities at the Hanford Site**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 195-202) (1990)

In 1943, as part of the war effort, the U.S. Army

Corps of Engineers selected the Hanford Site as the area to construct the first full-scale plutonium-production facilities. Between 1943 and 1955, eight production reactors were built at the Hanford Site, along with numerous support facilities, including major facilities used for the fuel separation process. Currently, over 100 of these facilities at the Hanford Site have been declared surplus and are to be decommissioned. This includes eight shutdown production reactors located in the Area 100 and two large fuel separation/process facilities located in the Area 200. Other than the ongoing required surveillance and maintenance work, there are three significant decommissioning project activities currently under way: (1) the decommissioning of the Strontium Semiworks Pilot Fuel Reprocessing Plant, (2) the closure/cleanup of the 183-H Solar Evaporation Basins, and (3) the planning for decommissioning of the eight surplus production reactors. This paper presents an overview of these decommissioning projects at Hanford, emphasizing the topics: project planning, description of reactor design, reactor decommissioning alternatives (with projected radiation doses and costs for each), and ongoing decommissioning work on the Strontium Semiworks facility and the 183-H Solar Evaporation Basins.

**30**

M.C. Hughes, R.K. Wahlen, and R.A. Winship, Westinghouse Hanford Company, Richland, WA

**Hanford Surplus Facilities Program Plan - FY 1990**

WHC-EP-0231-2; 100 pp. (September 1989)

The Hanford Surplus Facilities Program is responsible for the safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities at the Hanford Site. The management of these facilities requires a surveillance and maintenance program to keep them in a safe condition and development of a plan for ultimate disposition. Criteria used to evaluate each factor relative to decommissioning are based on the guidelines presented by the U.S. Department of Energy-Richland commitment to decommission the Hanford Site retired facilities in the safest and most cost-effective way achievable. This document outlines the plan for managing these facilities to the end of disposition.

**31**

M.G. Jones and R.B. Barber, Bechtel National, Inc., Oak Ridge, TN

**Development of a Waste Containment Structure for the Niagara Falls Storage Site**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 93-96) (1986)

The U.S. Department of Energy established the Niagara Falls Storage Site near Lewiston, New York, for the short-term (interim) storage of low-level radioactive wastes and residues. This paper describes the development of a containment structure for the waste materials and residues and describes the monitoring system that will be used to measure its performance. The interim containment structure can be modified to accommodate the waste materials for an effective design life of 200 to 1000 years. Thus it can serve as a long-term disposal facility. The means to be used for ultimate disposition of the waste will be announced in the U.S. Department of Energy Record of Decision, which is the culmination of the National Environmental Policy Act process conducted before the implementation of any federal action that could have a significant impact on the environment.

**32**

M.J. Kleeschulte, U.S. Geological Survey, Water Resources Division, Washington, DC

**Geohydrology of Bedrock Aquifers and Public Supply and Domestic Water Use, 1962-85, in St. Charles County, Missouri**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 41-74) (February 1991)

Three bedrock aquifers underlie St. Charles County. The shallow aquifer consists of Mississippian limestones and the middle aquifer of Kimmswick Limestone; both are used primarily for rural domestic water supply. The deep aquifer, which consists of formations from the top of the St. Peter Sandstone to the base of the Potosi Dolomite, is a source of public water supplies. The Ozark uplift, Lincoln fold, and Cap au Gres monocline are regional geologic structures that affect the groundwater hydrology of St. Charles County. Groundwater flow in the shallow aquifer is to the east across the county, with groundwater divides occurring between major streams. The local groundwater flow system of the deep aquifer in an eight-county area of eastern Missouri, which includes St. Charles County, is nearly independent of the regional flow. Groundwater divides and geologic structures prevent saline water from entering fresh water zones. Simulation of the groundwater flow system in St. Charles County indicates that a small quantity of water flows from the shallow aquifer to the deep aquifer, and that it takes centuries to do so. Increased groundwater pumpage caused by the rapid population increase in St. Charles County since 1950 has put additional stress on the local bedrock aquifers. Water use was calculated to be 5.05 million gal per day during 1962. The primary source of water at that time was the Missouri River, and the least used sources were the Mississippi River and Missouri River alluvial aquifers. Water use in the county was calculated to be 20.86 million gal per day during 1985. The primary source at that time was the alluvial aquifers and the least used source was the Missouri River.

33

M.J. Kleeschulte and P.W. Cross, U.S. Geological Survey, Rolla, MO

**Hydrologic Data for the Weldon Spring Chemical Plant Site and Vicinity Property, St. Charles County, Missouri, 1986-1989**

USGS-OFR-90-552; 123 pp. (1990)

This report contains hydrologic data collected during an investigation of the Weldon Spring chemical plant site and vicinity property in St. Charles County, Missouri, from May 1986 through September 1989. The data consist of water-quality analyses of samples collected from 10 locations at the Weldon Springs chemical plant site. These sites were selected because they typically have increased concentrations of uranium. Water-quality analyses from 57 wells, 19 springs, and 17 surface-water sites also are included. This report also includes daily mean specific conductance values from July 1987 through September 1989 for Burgermeister spring, Frog pond outflow, and Ash pond outflow; daily mean discharges for Burgermeister spring from May 1986 through September 1989 and for the unnamed tributary containing Burgermeister spring at Twin Island Lake and for Schote Creek at U.S. Highways 40 and 61 from August 1987 through September 1989; daily values of total precipitation from June 1987 through September 1989; well construction data; and water level measurements from May 1987 through August 1989.

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M.J. Kleeschulte and L.F. Emmett, U.S. Geological Survey, Denver, CO

**Compilation and Preliminary Interpretation of Hydrologic Data for the Weldon Spring Radioactive Waste Disposal Sites, St. Charles County, Missouri - A Progress Report**

USGS-WRIR-85-4272; 71 pp. (1986)

From 1957 to 1966 the Weldon Spring plant converted uranium-ore concentrates and recycled scrap to pure uranium trioxide, uranium tetrafluoride, and uranium metal. Residues from these operations were pumped to four large pits that had been excavated near the plant. Small springs and losing streams are present in the area. Water overlying the residue in the pits has a large concentration of dissolved solids and a different chemical composition compared to the native groundwater and surface water. This difference is indicated by the concentrations of calcium, sodium, sulfate, nitrate, fluoride, uranium, radium, lithium, molybdenum, strontium, and vanadium, all of which are greater than natural or background concentrations. Water from Burgermeister Spring, located about 1.5 miles north of the chemical plant area, contains uranium and nitrate concentrations greater than background concentrations.

Groundwater in the shallow bedrock aquifer moves northward from the vicinity of the chemical plant toward Dardenne Creek. An abandoned limestone quarry several miles southwest of the chemical plant also has been used for the disposal of radioactive waste and rubble. Groundwater flow from the quarry area is southward through the alluvium, away from the quarry and toward the Missouri River. Water from a well 4000 ft southeast of the quarry was analyzed; there was no indication of contamination from the quarry. Additional water quality and water level data are needed to determine whether water from the quarry moves toward the well field.

**35**

M.J. Kleeschulte and L.F. Emmett, U.S. Geological Survey, Rolla, MO

**Hydrology and Water Quality at the Weldon Spring Radioactive Waste-Disposal Sites, St. Charles County, Missouri**

USGS-WRIR-87-4169; 71 pp. (1987)

During October 1983 a study was begun to determine the extent and magnitude of surface water and groundwater contamination caused by low-level radioactive and associated wastes stored at the Weldon Spring Chemical Plant and nearby quarry site. Water overlying the uranium processing residues in four raffinate pits had much larger concentrations of calcium, sodium, sulfate, fluoride, nitrate, lithium, molybdenum, strontium, vanadium, radium, and uranium than native surface and groundwater. Groundwater from five monitoring wells adjacent to the raffinate pits had nitrate concentrations of 53 to 990 mg/l as nitrogen. Most of the water samples from these wells had increased concentrations of the following inorganic constituents (maximum concentration in mg/l): calcium (900), magnesium (320), sodium (340), and sulfate (320). Concentrations of several trace elements also were increased (maximum concentration in ug/l): lithium (1700), strontium (1900), and uranium (86). These concentrations indicate seepage from the raffinate pit area. Seismic studies made for the U.S. Department of Energy indicated a saturated overburden beneath raffinate pit 3, and possibly adjacent to pits 1, 2, and 4. A water-balance study indicated a 0.04-in. to 0.08-in. per day decrease in water level that cannot be explained by evaporation, probably from seepage into the underlying clays. Uranium concentrations as large as 250 ug/l have been detected in water from the Burgermeister spring. Dye tracer studies indicate that losing streams north of the chemical plant are hydrologically connected to Burgermeister Spring. One explanation for the increased uranium concentrations in the spring is that it receives uranium-contaminated water from losing-stream reaches of the tributary that contains Ash pond, which has uranium concentrations of 1,000 ug/l. Increased concentrations of nitrate and lithium in the spring indicates that it receives recharge from other sources, possibly the raffinate pits. Since no contamination plume has been detected between the pits and the spring, the contaminants may be migrating through preferred paths in the groundwater system such as fractures and solution openings. The Weldon Spring Quarry site, 3 miles southwest of the chemical plant, became a low-level radioactive waste disposal site in 1959. Water sampled from wells near the quarry and north of Femme Osage slough had uranium concentrations of 8.9 to 14,000 ug/l. Water from wells south of the slough had uranium concentrations of less than 5 ug/l. Water from the St. Charles County well field has only background concentrations of uranium.

**36**

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**Defense Decontamination and Decommissioning Overview**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 195-204) (April 1990)

This presentation provides a brief overview of the U.S. Department of Energy (DOE) Defense Decontamination and Decommissioning (DD&D) program. The program currently includes 68 projects at 17 sites around the country. A total of

342 facilities at these sites were used in defense-related activities overseen by DOE and its predecessor agencies. The budget for the DD&D program in FY 1990 was $47.7 million; in FY 1991 it is $88.2 million. The total estimated cost of the 30 year long program is $2,098 million. This presentation includes maps of facilities targeted for remediation in DD&D sites at (1) Mound, Ohio; (2) New Brunswick, New Jersey; (3) Idaho Falls, Idaho; (4) Oak Ridge, Tennessee; and (5) Hanford, Washington.

37

M.M. MacDonell, M.L. Maxey, J.M. Peterson, and L.A. Haroun, Argonne National Laboratory, Argonne, IL

**Removal Actions for Contaminated Surface Water at the Weldon Spring Site**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 451-462) (April 1990)

This presentation has four purposes: (1) to follow the documentation process for specific removal actions at the Weldon Spring site; (2) to discuss public participation in the remedial action program at Weldon Spring; (3) to review the lessons learned from the specific removal actions; and (4) to consider possible SEN-15-90 impacts on future removal actions at DOE Superfund sites. The specific removal actions referred to are the proposed management of contaminated surface water in the quarry and in impoundments at the chemical plant located at the Weldon Spring site.

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M.M. MacDonell, M.L. Maxey, J.M. Peterson, and I.E. Joya, Argonne National Laboratory, Argonne, IL; Morrison-Knudson Environmental Services, San Francisco, CA

**Engineering Evaluation/Cost Analysis for the Proposed Management of Contaminated Water Impounded at the Weldon Spring Chemical Plant Area**

DOE/OR/21548-106; 199 pp. (July 1990)

This engineering evaluation/cost analysis (EE/CA) report has been prepared to support the proposed removal action for managing contaminated surface waters impounded at the chemical plant area of the Weldon Spring site, located near Weldon Spring, Missouri. The U.S. Department of Energy is responsible for cleanup activities at the site under its Surplus Facilities Management Program (SFMP). The major goals of SFMP are to eliminate potential hazards to human health and the environment that are associated with contamination at SFMP sites and to make surplus real property available for other uses, to the extent possible. The objectives of this EE/CA report are to identify the cleanup as a removal action, document the selection of a response that will mitigate the potential release of radioactive or chemical contaminants from the impounded waters into the nearby environment, and address environmental impacts associated with the proposed action.

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**Addendum to Engineering Evaluation/Cost Analysis for the Proposed Management of 15 Nonprocess Buildings (15 Series) at the Weldon Spring Site Chemical Plant, Weldon Spring, Missouri**

DOE/OR/21548-136; 19 pp. (August 1990)

An engineering evaluation/cost analysis (EE/CA) report was prepared in May 1989 to analyze alternatives for a proposed removal action to manage 15 nonprocess buildings, designated as the 15 Series buildings, at the Chemical Plant area of the Weldon Spring site. The alternative selected as a result of the analyses was to dismantle the buildings and to salvage or transport off-site for treatment or disposal all nonradioactively contaminated materials and to store on-site in a material staging area (MSA) all radioactively contaminated materials, pending a decision for disposal of all wastes resulting from remediation of the Weldon Spring site. The U.S. Environmental

Protection Agency (EPA) Region VII and the state of Missouri concurred with the selection of this alternative and provided comments on the EE/CA report. The proposed removal action was not initiated at that time due to funding constraints. This addendum has been prepared to update information provided in the EE/CA report, provide additional information on the MSA, and respond to EPA Region VII and state of Missouri comments on the EE/CA.

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M.L. Maxey, M.M. MacDonell, and J.M. Peterson, Argonne National Laboratory, Argonne, IL

**Responsiveness Summary for the Engineering Evaluation/Cost Analysis for the Proposed Management of Contaminated Water Impounded at the Weldon Spring Chemical Plant Area**

DOE/OR/21548-144; 38 pp. (January 1991)

The U.S. Department of Energy (DOE) issued the Engineering Evaluation/Cost Analysis (EE/CA) for the proposed management of contaminated water impounded at the Weldon Spring Chemical Plant Area in July 1990. The EE/CA examines various alternatives for the proposed action to manage contaminated surface water impounded at the chemical plant area. The primary objective is to minimize potential migration of contaminants from surface impoundments to the local environment. The EE/CA concerns water currently impounded in four waste raffinate pits and two small ponds and water that will be impounded in the future as a result of upcoming response actions. Radioactive and chemical contaminants are migrating from the currently impounded water to underlying on-site groundwater via seepage and to off-site surface water via runoff. The treatment process and facilities that will be provided for management of currently impounded water can subsequently be used to manage other contaminated water in the future. Based on the evaluation of various alternatives in the EE/CA, DOE determined that the best approach for managing surface water impounded at the chemical plant area would be to remove contaminants from the water and release the treatment water to the Missouri River via a natural drainage channel. To establish requirements for releasing this treated water, DOE applied for a modification to its existing discharge permit from the Missouri Department of Natural Resources under the National Pollutant Discharge Elimination System program. The EE/CA provided a major source of technical input to the application for modifying the permit. This responsiveness summary has been prepared to address the major issues identified in oral and written comments on the proposed action.

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J.F. McGlynn and W.N. Rankin, Westinghouse Savannah River Company, Aiken, SC

**Foam and Gel Decontamination Techniques**

WSRC-RP-89-77; CONF-890488; Ceramics in Nuclear Waste Management, Proceedings of the Fourth International Symposium, Indianapolis, IN, April 23-27, 1989; (20 pp.) (1989)

The Savannah River Site is investigating decontamination technology to improve current decontamination techniques and thereby reduce radiation exposure to plant personnel, reduce uptake of radioactive material, and improve safety during decontamination and decommissioning activities. When decontamination chemicals are applied as foam and gels, the contact time and cleaning ability of the chemical increases. Foam and gel applicators apply foam or gel that adheres to the surface being decontaminated for periods ranging from fifteen minutes (foam) to infinite contact (gel). This equipment was started up in a cold environment. The desired foam and gel consistency was achieved; operators were trained in its proper maintenance and operation; and the foam and gel were applied to walls, ceilings, and hard-to-reach surfaces.

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J. McKee and M. Sizemore, U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, MO

**Weldon Spring Remedial Action Project - Waste Water Treatment System for the**

**Chemical Plant Site**

DOE Information Bulletin; 4 pp. (1990)

This public information bulletin describes the proposed waste water treatment system for the Chemical Plant Site at the Weldon Spring Remedial Action Project. The system will include an equalization basin, water-treatment plant, and two effluent ponds needed to remove various contaminated surface-water sources. The system will produce treated water close to drinking water standards, released according to protective permit limits. In the bulletin, the public is advised of a public meeting on August 16, 1990, to describe the plans, invite comment, and give responses to the public comments. A letter from the project manager accompanies this bulletin, indicating that the bulletin was enclosed with a copy of the engineering evaluation/cost analysis (EE/CA) for the proposed waste water treatment system. The letter includes a nine-page distribution list of addressees for the EE/CA and information bulletin.

**43**

J.A. Meier, Jacobs Engineering Group, Inc., St. Charles, MO

**Characterization of Preferred Groundwater Migration Pathways - Weldon Spring Site**

CONF-9005149; Aquifer Restoration, Groundwater Monitoring, and Geophysical Methods, Proceedings of the Fourth National Outdoor Action Conference, Las Vegas, NV, May 14-17, 1990, 1333 pp.; (pp. 1277-1290) (1990)

Through the Weldon Spring Site (WSS) Remedial Action Project, the U.S. Department of Energy is currently executing a full remedial investigation/feasibility study and environmental impact statement at the former Weldon Spring Uranium Feed Materials Plant, in compliance with Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act and National Environmental Policy Act guidelines. As part of the overall environmental characterization program for the project, contaminant transport through various water pathways was investigated. The project site and surrounding region is underlain by fractured and solution-affected Burlington-Keokuk limestone. Small perennial and intermittent springs and losing streams are characteristic of the region. Identification of the transport mechanisms and the environmental fate of contaminants are complicated by a preferred fracture flow that is superimposed onto a groundwater system that exhibits primarily porous-medium flow characteristics. Given the complex hydrogeologic regime present at WSS, with the conduit flow system apparently superimposed upon the effectively porous-medium bedrock conditions, a multifaceted approach to characterization of preferred fracture flow has been developed. The use of monitoring wells, spring inventorying and sampling, down-hole camera observations, dye studies, aquifer testing, aerial photography interpretation, and seepage runs have all contributed to the understanding of the interaction of flow systems and the source-to-discharge mechanics at WSS. Application of these techniques is essential to understanding the complexities that secondary structure and solutional effects impose on contaminant migration in carbonate systems.

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J.A. Meier, Jacobs Engineering Group, Inc., St. Charles, MO

**Summary of Groundwater Quality at the Weldon Spring Site, St. Charles, Missouri**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 75-86) (February 1991)

The chief groundwater contaminants at the Weldon Spring site are nitrate, sulfate, uranium, and nitroaromatics. The raffinate pits are the chief possible sources of nitrates. The sources of uranium in the groundwater are the raffinate pits and possibly the former process buildings. All sources of sulfate contamination are not identified, but the raffinate pits and residual soils contamination play a major role as sources. The distribution of nitroaromatic contamination in the groundwater is sporadic and relatively low-level, at averages generally less than 5 ppb; although the levels of dinitrotoluene can exceed the ambient water quality criteria of 0.11 ppb. Nitroaromatic contamination extends beyond the site, but its full extent is unknown.

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K.A. Meyer Jr., Jacobs Engineering Group, Inc., Albuquerque, NM

**Designing Chemical Soil Characterization Programs for Mixed Waste Sites**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 531-533) (1989)

The Weldon Spring Site Remedial Action Project is a remedial action effort funded by the U.S. Department of Energy. The Weldon Spring Site, a former uranium-processing facility, is located in east-central Missouri on a portion of a former ordnance works facility that produced trinitrotoluene during World War II. As a result of both uranium and ordnance production, the soils have become both radiologically and chemically contaminated. As a part of the site characterization efforts in support of the environmental documentation process, a chemical, soil-characterization program was developed. This program consisted of biased and unbiased sampling programs that maximized areal coverage, provided a statistically sound data base, and maintained cost effectiveness. This paper discusses how the general rationale and processes used at the Weldon Spring Site can be applied to other mixed and hazardous waste sites.

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K.A. Meyer Jr., Jacobs Engineering Group, Inc., St. Charles, MO

**Dedicated Ground Water Sampling Systems - A Technical and Economic Evaluation**

CONF-9005149; Aquifer Restoration, Groundwater Monitoring, and Geophysical Methods, Proceedings of the Fourth National Outdoor Action Conference, Las Vegas, NV, May 14-17, 1990, 1333 pp.; (pp. 341-346) (1990)

The Weldon Spring Site, a 12-year, $400 million remedial action project sponsored by the U.S. Department of Energy, has used both dedicated and nondedicated groundwater sampling systems for the past three years. During that time, numerous technical and economic benefits of the dedicated sampling systems have been realized. Dedicated sampling systems are recommended in numerous groundwater monitoring and investigation documents but are too often dismissed without a thorough evaluation. The benefits realized at the Weldon Spring Site demonstrate that dedicated sampling systems are a cost-effective and technically superior solution.

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K.A. Meyer Jr., Jacobs Engineering Group, Inc., St. Charles, MO

**Ground Water Monitoring and Waste Water Management - A Risk Based Approach**

CONF-9005149; Aquifer Restoration, Groundwater Monitoring, and Geophysical Methods, Proceedings of the Fourth National Outdoor Action Conference, Las Vegas, NV, May 14-17, 1990, 1333 pp.; (pp. 897-903) (1990)

The Weldon Spring Site Remedial Action Project (WSSRAP), a 12-year, $400 million remedial action project sponsored by the U.S. Department of Energy, has installed numerous groundwater monitoring wells over the past several years which it routinely samples. The problems of disposal of water removed during well development and purging prior to sampling were recently identified. Numerous alternatives were evaluated and a solution formulated. The solution consists of classifying the water using risk-based criteria and handling the two classes of water as appropriate using the facilities currently available. The approach presented in this manuscript is currently being reviewed by the Environmental Protection Agency and the state of Missouri. The methods and concepts used in developing this process may be applicable to other sites.

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K.A. Meyer Jr., Jacobs Engineering Group, Inc., St. Charles, MO

**The History of the Weldon Spring Site and a Summary of Historic Geologic Investigations**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 7-16) (February 1991)

Various agencies have studied the geology of the Weldon Spring site since the 1940s. The complexity of the geology has required the services of the U.S. Geological Survey, the Missouri Department of Natural Resources, the U.S. Department of Energy (DOE), and numerous DOE contractors. These studies show that the sources of contamination are known, the extent of contamination is essentially defined, and the geology and hydrology of the site is understood.

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R.H. Miller and R.A. Nelson, Jacobs Engineering Group, Inc., St. Charles, MO

**Inventory, Classification, Segregation, Bulking, and Disposal of Mixed Containerized Waste at the Former Weldon Spring Uranium Feed Materials Plant**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 229-234) (March 1989)

This paper presents the planning, regulatory interface and operational experience associated with the inventory, sampling, handling, segregation, and disposal of containerized chemicals and other materials at a former uranium feed materials plant now being decommissioned as the Weldon Spring Site Remedial Action Project. A preliminary inventory performed without documentation of the nature of materials stored throughout the entire 166-acre Weldon Spring Chemical Plant identified approximately 310 major groups of containers. These groups represented about 4000 individual containers. It was estimated that the approximately 20,000 l of unknown liquids and approximately 28,000 l of unknown solids present in the containers could have possible elevated levels of natural series isotopes (primarily uranium) from their use in the uranium production activities during plant operation. The inventory indicated that 55% of the materials were likely to be listed as hazardous wastes under the Resource Conservation and Recovery Act (RCRA). Based primarily on the container integrity, it was also estimated that about 5% of the containerized waste was contaminated with uranium at levels detectable using hand-held field instruments. A plan to sample and segregate radiologically and nonradiologically contaminated materials was developed. This plan also included the consolidation of wastes in each category by compatible chemical classes and the disposal of the nonradiologically contaminated chemical waste at off-site licensed facilities. Chemical sampling and laboratory methods were performed consistent with U.S. Environmental Protection Agency (EPA) methods (SW-846). By means of in situ radiation measurements using hand-held detection instruments, the wastes were segregated and subsequently consolidated. Additional sampling was then performed to establish actual value radiological levels in the various groups. After discussion of the resultant radiological levels with the state RCRA agency and EPA, all wastes containing levels below those agreed upon will be disposed of off-site. Materials containing levels above the negotiated release criteria will be retained on-site to await disposition along with the remainder of the other wastes at the Weldon Spring Site according to the Comprehensive Environmental Response, Compensation, and Liability Act process.

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R.L. Miller and J.M. Steffes, UNC Nuclear Industries, Richland, WA

**Radionuclide Inventory and Source Terms for**

### the Surplus Production Reactors at Hanford

UNI-3714; 108 pp. (June 1986)

Radionuclide inventories have been estimated for the eight surplus production reactors at Hanford. The inventories listed in this report represent more than 95% of the total curie burden; the remaining 5%is distributed in piping, tunnels, and various other locations within the reactor building and unaccounted for inventories within the reactors or fuel storage basins. Estimates are conservative, as the methodology was designed to overestimate the radionuclide inventories in the facilities. The estimated inventory per reactor facility ranges from 13,000 curies to 58,000 curies. The majority of the present inventory consists of tritium, carbon-14, cobalt-60, and nickel-63, The information in this document combines data from past characterization efforts and introduces adjustments for added information and refinement. Since the reactors have been shut down from 15 to 20 years, many of the shorter half-life radionuclides have decayed to insignificant levels and are therefore not addressed in this report. Trace amounts of some of the longer half-life radionuclides are listed only to show that they were evaluated. The inventory of hazardous materials in the reactor facilities is also addressed.

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Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO

### Shallow Groundwater Investigations at Weldon Spring, Missouri: Final Report for Fiscal Years 1988-1990

Report; 98 pp. (December 1990)

The Missouri Department of Natural Resources, Division of Geology and Land Survey (MDNR-DGLS) conducted investigations of the upper aquifer in the vicinity of the abandoned Weldon Spring Chemical Plant in southwest St. Charles County, Missouri. The study began October 1, 1987, and ended September 30, 1990. The study area included most of the original Weldon Springs Ordinance Works property plus a smaller area to the northeast between U.S. Highway 40-61 and Dardenne Creek. The investigations included a literature review, classification of stream segments as gaining (effluent) or losing (influent), location of springs, water-tracing tests, testing of the spontaneous potential geophysical technique, continuous gauging of selected streams, and continuous water-level monitoring in selected monitoring wells. The objective of the investigation was to better define the relationships between precipitation, surface runoff, groundwater recharge, and shallow groundwater discharge within the study area, thereby assisting the Department of Energy in designing an appropriate groundwater monitoring plan for the Weldon Spring Site Remedial Action Project. The results of investigations presented in this report indicate that water movement in the upper aquifer around the Weldon Spring Site has been significantly influenced by solution activity in the carbonate bedrock. The many springs, losing streams, and several sinkholes that have been identified in the study area suggest this conclusion, and the dramatic results of tracer tests conducted during this study demonstrate it. Previous studies also indicate that substantial water movement takes place through solution cavities, fractures or solution-enlarged features. Although the effects of solution features are widely evident in the vicinity of the chemical plant, these effects are not seen on the site.

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### Possible Seismic Effects at the Weldon Spring Site

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 297-308) (February 1991)

Minor earthquake activity occurs throughout the central United States. Much greater activity can, however, occur in seismogenic zones associated with tectonic features such as rifts, uplifts, basins, and former plate boundaries. Among these, the Ozark uplift and the New Madrid fault are of interest because they could generate damaging ground motion at the Weldon Spring site. Activity in the New Madrid seismic zone dominates the earthquake history of the central U.S. In the winter of 1811-1812, three of the largest earthquakes ever recognized in North America occurred in the New Madrid seismic zone.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**WSSRAP (Weldon Spring Site Remedial Action Project) Chemical Plant Geotechnical Investigations: Appendices C and D**

DOE/OR/21548-158 (App. C-D); 358 pp. (December 1990)

This document contains appendices C and D for the Weldon Spring Site Remedial Action Project (WSSRAP). This report presents the results of site geotechnical investigations conducted in the vicinity of the Weldon Spring chemical plant and raffinate pits and in potential on-site and off-site clayey material borrow sources. Included are coordinates on boreholes and a summary of permeability test result corrections. The contents of this document include (1) Appendix C-1, Coordinates of Boreholes; (2) Appendix C-2, Groundwater Level Monitoring Data (August 1989-August 1990); (3) Appendix D, Laboratory Soil Test Data Sheets; and (4) Appendix D-1, Summary of Permeability Test Result Corrections.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**WSSRAP Geosciences Workshop**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp. (February 1991)

The manuscripts in these proceedings represent current understanding of geologic issues associated with the Weldon Spring Site Remedial Action Project (WSSRAP). The objective of the workshop and proceedings is to provide the public and scientific community with technical information that will facilitate a common understanding of the geology of the Weldon Spring site, of the studies that have been and will be conducted, and of the issues associated with current and planned activities at the site. Manuscripts were prepared by scientists and engineers employed by the WSSRAP contractor organization, employees of the Missouri Department of Natural Resources, and scientists from St. Louis University, Argonne National Laboratory, and the U.S. Geological Survey. The major topics covered are (1) the geology and geomorphology of the Weldon Spring Site area, (2) the geohydrology of the site, and (3) groundwater quality in and around the site. There are over 80 figures and 26 tables accompanying the 14 papers given in these proceedings.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**Aquifer Characteristics Data Report for the Weldon Spring Site Chemical Plant/Raffinate Pits and Vicinity Properties**

DOE/OR/21548-122; 122 pp. (November 1990)

The Weldon Spring Site, about 48 kilometers (30 miles) from St. Louis, Missouri, was the location of a World War II Department of the Army explosives production facility and later an Atomic Energy Commission (AEC) uranium feed materials plant (1957-1966). Part of the AEC facility became an Army chemical plant for the production of herbicides in 1967, but the plant never went into production. The remaining property included four process-waste lagoons called the raffinate pits. In 1984, the U.S. Department of Energy assumed control of the chemical plant site along with the raffinate pits, and in 1985 began a remedial action program for the entire Weldon Spring Site and related vicinity properties. A site characterization program supports the Comprehensive Environmental Response, Compensation, and Liability Act Remedial Investigation/Feasibility

Study of the Weldon Spring Site Remedial Action Project. As part of the characterization program, this report describes the procedures and methods used and presents the results of physical testing performed to characterize the hydraulic properties of the shallow Mississippian-Devonian aquifer beneath the Weldon Spring chemical plant, raffinate pits, and vicinity properties. The aquifer of concern is composed of saturated rocks of the Burlington-Keokuk Limestone which constitutes the upper portion of the Mississippian-Devonian aquifer. This aquifer is a heterogeneous anisotropic medium that can be described in terms of diffuse Darcian flow overlain by high porosity discrete flow zones and conduits. Average hydraulic conductivity for all wells tested is 9.6(E-02) m/d (3.1(E-01) ft/d). High hydraulic conductivity values are representative of discrete flow in the limestone. They indicate heterogeneities within the Mississippian-Devonian aquifer. Aquifer heterogeneity in the horizontal plane is believed to be randomly distributed and is a function of fracture spacing, solution voids, and preglacial weathering phenomena. Relatively high hydraulic conductivities in deeper portions of the aquifer are thought to be a result of the presence of widely spaced fractures. Pumping tests conducted in the upper 12 m (39 ft) of saturated bedrock provided values for transmissivity which ranged from 0.19 to 0.49 sq m/d (15.5 to 39.9 gal/d/ft). The average storativity determined from pumping tests is 4.9(E-04). Results of pumping tests indicate a primary lateral anisotropy and poor hydraulic communication between pumped intervals and deeper portions of the Burlington-Keokuk Limestone. This suggests that appreciable upward leakage is unlikely from deeper portions of the aquifer to the test interval. Limited evidence of delayed yield may indicate double porosity effects. Groundwater velocities average 1.1(E-01) m/d (3.6(E-01) ft/d). Calculated groundwater velocities and travel times are consistent with observed contaminant distribution, although actual flowpaths are expected to exhibit nonlinear aspects resulting in significant variations in velocity. Pumping and tracer tests did not intercept free-flow zones, or conduits capable of supplying sustained pumpage in excess of 1.5 L/min (0.4 gal/min). However, slug testing indicates the existence of randomly distributed, high-porosity zones in the upper saturated portion of the formation. Additional pumping tests in these locations would provide information on discrete flow properties.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**Weldon Spring Site Remedial Action Project: Annual Site Environmental Report, 1989**

DOE/OR/21548-129 (Rev. 1); 270 pp. (November 1990)

This report presents the findings of the environmental monitoring program conducted during 1989 in and around the Weldon Spring Site (WSS), a U.S. Department of Energy surplus facility in St. Charles County, Missouri. Annual environmental reports have been prepared for this site (or portions thereof) since 1981. WSS is comprised of the Weldon Spring Raffinate Pits (WSRP), which contain uranium and thorium processing residues; the Weldon Spring Chemical Plant (WSCP), formerly used as an explosives production facility and later as the Weldon Spring Uranium Feed Material Plant; and the Weldon Spring Quarry (WSQ), used for storage of chemically and radioactively contaminated wastes. The 1989 environmental monitoring program attempted to identify, characterize, and monitor release pathways for both radiological and chemical constituents. Numerous exposure pathways were monitored, including groundwater, surface water, and air. Following extensive characterization efforts conducted as part of the remedial investigations in 1988, an expanded quarterly monitoring program was instituted to collect additional data for evaluation of seasonal or time-based trends in contaminant concentrations. Data were collected from 91 groundwater monitoring wells, surface-water sampling at 45 locations, 22 locations monitored for radon and external gamma radiation exposure, and air particulate sampling along the site perimeter. Analytical parameters included radionuclides, nitroaromatic compounds, inorganic anions, and direct gamma exposure. The results are used to calculate exposure doses so the impact of the site on potentially exposed populations can be assessed. The maximum calculated annual radiation dose to a hypothetically exposed individual was less than 1 mrem at the WSRP/WSCP area and vicinity properties and 3.5 mrem at the WSQ area. Off-site exposure did not dramatically increase in 1989 over previous years. Contaminated groundwater did not affect private water supplies or the St. Charles County well field. Surface water containing elevated uranium activity continued to impact the Femme Osage Slough and several lakes in August A. Busch Memorial Wildlife Area. Elevated radon exposures at WSQ continued in 1989 due to unusually dry conditions. Off-site gamma, radon, and air particulate exposures remained indistinguishable from background. Related activities were conducted in 1989 to support the remedial investigation/feasibility study, including radiological characterization of WSCP buildings and minor storm-water discharge points, shallow groundwater well monitoring, and radon decay product monitoring.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**Quarry Geotechnical Report for the Weldon Spring Site Remedial Action Project**

DOE/OR/21548-147; 214 pp. (November 1990)

The Weldon Spring Site in Missouri comprises the Weldon Spring quarry area and the Weldon Spring chemical plant and raffinate pit areas. This report presents the results of geotechnical investigations conducted during 1989-90 at the proposed Weldon Spring quarry staging and water treatment facilities in the quarry area. The facilities are intended for treatment of water removed from the quarry area. An access road and a decontamination pad will be necessary for handling and transporting bulk waste resulting from the site remedial action. The quarry geotechnical report provides geotechnical data, summarizes findings, and proposes recommendations for the design of the proposed facilities. The geotechnical program was planned and executed based on a 1989 MK-Ferguson preliminary design of the proposed facilities. Field investigations were performed between February and May 1989. The scope of the MK-Ferguson field investigation at the quarry included review and summary of previous investigations, overseeing drilling and piezometer installation, preparing laboratory test programs, evaluating test results, performing foundation analyses, preparing geotechnical recommendations, and reporting on these items in this report. An additional slope stability analysis was performed in April 1990 to evaluate the embankments of the equalization basin and effluent ponds under the effect of a 100-year flood in the Little Femme Osage Creek. This analysis is outside the scope of the geotechnical report, but is included here for reference.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**Screening Level Characterization of Electrical Substation 411**

DOE/OR/21548-154; 53 pp. (November 1990)

This report presents characterization data for the Number 411 Electrical Substation located on Department of Conservation properties south of the Weldon Spring Chemical Plant on the Weldon Spring Site in Missouri. Sample collection methods, sampling equipment, and analytical results are also presented in this report. The objective of this characterization is to supply data needed to prepare a subcontract package for the removal of all transformers and dielectric fluids contained in Substation 411. The transformer dielectric fluids were sampled for uranium and polychlorinated biphenyls (PCBs). The exterior surfaces of the metal transformers were measured for radioactivity. Results of the sampling revealed that some transformer fluid contained PCBs, but no uranium in excess of naturally occurring amounts was detected. In addition, the exterior surfaces of the transformers were uncontaminated. Subject to measurement of the base of the transformers (inaccessible during surface scans), the transformers and dielectric fluids may be removed from the site for disposal.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**WSSRAP (Weldon Spring Site Remedial Action Project) Chemical Plant Geotechnical Investigations: Appendix A, Phase 1 - Borehole, Piezometer and Test Pit Logs**

DOE/OR/21548-158 (App. A); 410 pp. (December 1990)

This document has been prepared for the U.S. Department of Energy Weldon Spring Site Remedial Action Project (WSSRAP). This report presents the results of site geotechnical investigations conducted by the project management contractor in the vicinity of the Weldon Spring chemical plant and raffinate pits and in potential on-site and off-site clayey material borrow sources. This document, Appendix A, contains information for Phase 1 of WSSRAP for boreholes, piezometer logs, and test pit logs.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**WSSRAP (Weldon Spring Site Remedial Action Project) Chemical Plant Geotechnical Investigations: Appendix B, Phase 2 - Borehole, Piezometer and Test Pit Logs**

DOE/OR/21548-158 (App. B.); 494 pp. (December 1990)

This document has been prepared for the U.S. Department of Energy Weldon Spring Site Remedial Action Project (WSSRAP). This report presents the results of site geotechnical investigations conducted by the project management contractor in the vicinity of the Weldon Spring chemical plant and raffinate pits and in potential on-site and off-site clayey material borrow sources. This document, Appendix B, contains information for phase II of WSSRAP for borehole, piezometer logs, and test pit logs.

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MK-Ferguson Company, St. Charles, MO; Jacobs Engineering Group, Inc., St. Charles, MO

**WSSRAP Chemical Plant Geotechnical Investigations**

DOE/OR/21548-158; 120 pp. (December 1990)

This report presents the results of site geotechnical investigations conducted in the vicinity of the Weldon Spring Site chemical plant and raffinate pits, and in potential clayey material borrow sources on-site and off-site. The chemical plant and raffinate pits area is the proposed location of the Weldon Spring Site disposal cell. The disposal cell will be used for long-term storage of contaminated waste materials generated from cleanup of the Weldon Spring Site. This document presents the geotechnical field and laboratory data that were obtained to characterize overburden materials (not including subsurface soils and foundation) in support of proposed remedial action activities for the disposal cell. These data are part of the data collection for the Weldon Spring Site remedial investigation/feasibility study. The data will also be used to support remedial investigation documentation, the site suitability study, and the design of the proposed disposal cell, including temporary facilities. The investigations were conducted in two phases. Phase I (June-August 1988) included drilling in the west dike of Raffinate Pit 4, in the proposed administration building footprint (since constructed), and in the proposed disposal cell area. On-site test pits from which clay or fill material might be borrowed were excavated by backhoe. Surface geophysical surveys were performed. Phase II (January 1989-August 1990) included drilling angled boreholes, drilling boreholes and installing piezometers within and adjacent to the proposed disposal cell area, drilling in the proposed temporary storage area, and excavating test pits in two potential off-site areas for clay borrow sources. A summary of these investigations is listed in table form in this report, along with locations of boreholes, piezometers, wells, pits, geophysical survey lines, and test pits. The geotechnical site investigations also included the relogging of rock cores from boreholes drilled during previous investigations.

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E.B. Moore, Pacific Northwest Laboratory, Richland, WA

**Alternatives for Decommissioning the Surplus Production Reactors at Hanford**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 91-93) (1990)

Alternatives for decommissioning eight surplus plutonium production reactors owned by the U.S. Department of Energy (DOE) at the Hanford Site were analyzed in a draft environmental impact statement published by DOE in March 1989. The alternatives are (1) no action, (2) immediate one-piece removal, (3) safe storage followed by deferred one-piece removal, (4) safe storage followed by deferred dismantlement, and (5) in situ decommissioning. The environmental impacts of decommissioning by any alternative are not great, the most significant impact being worker exposure to radioactivity. This impact (for all eight reactors) is approximately equal to the annual worker dose at a large commercial nuclear power plant. Uncertainty as to the applicability to decommissioning of the Resource Conservation and Recovery Act and/or the Comprehensive Environmental Response, Compensation, and Liability Act may become an issue in the implementation of decommissioning.

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W.E. Murphie, U.S. Department of Energy, Washington, DC

**Shippingport Station Decommissioning Project: Overview and Progress Report for the Fiscal Years 1984-1985, 1986 and 1987**

IAEA-TECDOC-511; 102 pp.; (pp. 93-102) (June 1989)

A general project overview of the Shippingport Station decommissioning program is given. This includes the background of the project and the development and implementation of plans for management, engineering, and site operations. The technical objectives of the project are highlighted. Removal of reactor and internals in one piece is a special feature of this project. The physical work of decommissioning started in 1985, with the site release scheduled for 1990.

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W.E. Murphie, U.S. Department of Energy, Washington, DC

**Decision Process Involved in Preparing the Shippingport Reactor Pressure Vessel for Transport**

Regulatory Philosophy and Intent of Radioactive Material Transport Including Transport of Components from Decommissioned Nuclear Facilities, Proceedings of the 1990 Pressure Vessels and Piping Conference, Nashville, TN, June 17-21, 1990. American Society of Mechanical Engineers, New York, NY; (pp. 47-51) (1990)

A complete reassessment of the regulatory requirements governing the Shippingport reactor pressure vessel shipment resulted in a programmatic decision to obtain a Type B(U) Certification of Compliance and abandon the originally planned U.S. Department of Transportation (DOT) low specific activity (LSA) shipment. The decision process resulting in this conclusion was extensive and involved many organizations and agencies. Incidental to this process, several subtle certification issues were identified that required resolution. Some of these issues were (1) the definition of LSA material for large packages; (2) interpretation and compliance with the U.S. Department of Energy (DOE), DOT and U.S. Nuclear Regulatory Commission regulations for the transport of radioactive material; (3) incorporation of the International Atomic Energy Agency regulations by the Panama Canal; and (4) DOE policy requiring advance notification to states of radioactive waste shipments.

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R.F. Nelson and Y. Noorani, Jacobs Engineering Group, Inc., St. Charles, MO

**Personal Computer Software Tools for Effective Data Management of Environmental, Safety, and Health Compliance at a Remedial Action Project**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 505-509) (1990)

The use of personal computers in environmental monitoring and regulatory compliance is best demonstrated by a hands-on session with the software tools developed during conduct of the Weldon Spring Site Remedial Action Project (WSSRAP). Various software and data bases have been created at WSSRAP using personal computers for data management of environmental monitoring and compliance data. These include EST - "Environmental Systems Tracking," GURU - "Generic Universal Reporting Utility," SHARP - "Safety, Health and Radiation Protection," which is a personal training and participation records system, and WITS - "Waste Inventory and Tracking System." These practical data base tools allow fast information access, flexible reporting formats (as compliance requirements change), and timely automatic notification of upcoming training or submittal needs. Using readily available applications software for personal computers, tailored programs are demonstrated on actual remedial action project databases. Specific examples include (1) tracking of a mixed waste environmental sample continuously from collection through analysis and reporting with invoice payment authorization (EST and GURU); (2) training refresher documentation for 40-hour Occupational Safety and Health Act (29 CFR 1910.120) requirements, personnel dosimetry, and medical surveillance results on a typical radiation worker handling mixed waste at a National Priorities List site (SHARP); and (3) disposition and reporting requirements for capacitors containing Polychlorinated Bithenyls dielectric oil and exhibiting surface radioactivity in excess of releasable limits (WITS).

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F. Otsubo, Shimizu Construction Company Limited, Tokyo, Japan

**Shippingport Station Decommissioning Project**

FAPIG (First Atomic Power Industry Group, Tokyo) 125:33-41 (July 1990)

The decommissioning of a nuclear power station is the main issue for each country with nuclear power stations. Techniques for radiological control, waste management, and environmental impact prevention are currently in the stage of research and development. The Shippingport Atomic Power Station is the first commercial-size light-water reactor in the world and the first reactor to be decommissioned. The purposes of this project were: (1) to dismantle the radioactivated portion of the station, (2) to place the station in a radiologically safe condition, (3) to demonstrate to the nuclear industry the practical and affordable decommissioning of a large size nuclear power station using conventional techniques, and (4) to provide useful data for future projects of this kind.

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J.M. Peterson and M.M. MacDonell, Argonne National Laboratory, Argonne, IL

**Responsiveness Summary for the Remedial Investigation/Feasibility Study for Management of the Bulk Wastes at the Weldon Spring Quarry, Weldon Spring, Missouri**

DOE/OR/21548-135; 102 pp. (August 1990)

The U.S. Department of Energy (DOE) is responsible for conducting remedial actions at the Weldon Spring Site in St. Charles County, Missouri, under its Surplus Facilities Management Program. The site consists of a quarry and a chemical plant area located about 6.4 km (4 miles) northeast of the quarry. The quarry is surrounded by the Weldon Spring Wildfire Area and is near an alluvial well field that constitutes a major source of potable water for St. Charles County; the nearest supply well is located about 0.8 km (0.5 miles) southeast of the quarry. From 1942 to 1969, the quarry was used for the disposal of various radioactively and chemically contaminated materials. Bulk wastes in the quarry consist of contaminated soils and sediments, rubble, metal debris, and equipment. As part of the overall site remediation, DOE is proposing to conduct an interim remedial action at the quarry to manage the radioactively and chemically contaminated bulk wastes contained therein. Potential remedial action alternatives for managing the quarry bulk wastes have been evaluated in a manner that is consistent with U.S. Environmental Protection Agency (EPA) guidance for conducting remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act, as amended. These documents were developed in consultation with EPA Region VII and the state of Missouri and reflect the focused scope defined for this interim remedial action.

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J.M. Peterson and M.M. MacDonell, Argonne National Laboratory, Argonne, IL

**Engineering Evaluation/Cost Analysis for the Proposed Management of Contaminated Structures at the Weldon Spring Chemical Plant**

DOE/OR/21548-159; 107 pp. (May 1991)

This engineering evaluation/cost analysis (EE/CA) report has been prepared to support the proposed removal action for managing contaminated structures at the chemical plant area of the Weldon Spring site, located in St. Charles, Missouri. The U.S. Department of Energy is responsible for cleanup activities at the site under its Surplus Facilities Management Program. This EE/CA report was prepared to document the proposed removal action because the action is a nontime-critical response. This documentation process is identified in guidance of the U.S. Environmental Protection Agency (EPA) which addresses removal actions at sites subject to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. Actions at the Weldon Spring site are subject to CERCLA requirements because the site is listed on the EPA National Priorities List. The objectives of this report are to (1) identify alternatives for managing the contaminated structures at the chemical plant area; (2) document the selection of a response that will mitigate the potential threat to workers, the general public, and the environment associated with these structures; and (3) address health and environmental impacts associated with the proposed action. The proposed removal action is to (a) decontaminate the contaminated structures (i.e., remove loose radiative contamination and asbestos and polychlorinated biphenyl contamination), (b) remove material currently within these structures and transport it to on-site temporary storage areas, and (c) dismantle the structures and transport the resultant waste to on-site temporary storage areas. This action is consistent with and would support comprehensive response actions being planned for the Weldon Spring site.

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J.M. Peterson, M.M. MacDonell, and L.A. Haroun, Argonne National Laboratory, Argonne, IL

**Expediting Cleanup at the Weldon Spring Site Under CERCLA and NEPA**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 125-129) (March 1989)

The Weldon Spring Site Remedial Action Project is being conducted under the U.S. Department of Energy (DOE) Surplus Facilities Management Program. DOE has developed an environmental compliance strategy for this project to meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA). A key element of this strategy was the development of an integrated CERCLA/NEPA process to minimize, to the extent possible, the need to prepare duplicate documentation. Additionally, the project is implementing various expedited response actions to mitigate actual or potential uncontrolled releases of radioactively or chemically hazardous substances to the environment and to minimize potential health and safety risks to on-site personnel and local human and biotic populations. These actions are being conducted concurrently with the implementation of site characterization activities and the preparation of major environmental compliance documentation. The initiation of site cleanup via these response actions has fostered a very positive relationship with the U.S. Environmental Protection Agency Region VII, the state of Missouri, and the affected public.

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J.M. Peterson, M.M. MacDonell, L.A. Haroun, M.J. Davis, and S.H. McCracken, Argonne National Laboratory, Argonne, IL

**Strategy for Remedial Action at a Buried Waste Operable Unit of the Weldon Spring Site**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 55-66) (April 1990)

The Weldon Spring Site Remedial Action Project is being conducted under the Surplus Facilities Management Program of the U.S. Department of Energy. The site is located about 48 km (30 mi) west of St. Louis, Missouri, and consists of two noncontiguous areas: an inactive chemical plant and a quarry. The quarry was used to dispose of radioactively and chemically contaminated materials from the 1940s through the 1960s. The materials buried in the quarry constitute the source of contaminants that are being released to the atmosphere and leached into underlying groundwater. An interim remedial action has been proposed for the quarry to mitigate potential health and environmental impacts associated with contaminant migration and to support comprehensive cleanup of the Weldon Spring site. Under the preferred alternative for this interim action, the contaminated quarry materials would be excavated and transported to the chemical plant area for controlled storage, pending the decision on site disposition. This action would permit detailed characterization of both the waste materials and the quarry subsurface, which would support overall site cleanup decisions. The strategy for defining the scope of the quarry waste operable unit and the unit's role in both the final quarry remediation and the disposition of the entire site, was developed consistently with the requirements of the National Environmental Policy Act and the Comprehensive Environmental Response, Compensation, and Liability Act. A focused remedial investigation/feasibility study was prepared for this action; its support documents include the baseline risk evaluation and engineering reports. Informational meetings with local interested parties were held prior to the recent public meeting for this action, and the response has been generally favorable.

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D.K. Ploetz and I.M. Leonard, West Valley Nuclear Services Company, Inc., West Valley, NY

**Supernatant Treatment System Design Through Testing**

DOE/NE-44139-47; 120 pp. (December 1988)

This report discusses construction and testing of the Supernatant Treatment System (STS) at the Western New York Nuclear Service Center. The main purpose of the STS is to remove more than 99.9% of the radioactive cesium (Cs-137) from the high-level waste stored in tank 8D-2 on-site. Cesium removal is accomplished in the STS by processing the supernatant (liquid) portion of the high-level waste through three or four ion exchange columns filled with zeolite. After treatment in the STS, the decontaminated supernatant is processed as low-level waste and finally encapsulated in cement for eventual disposal. The Cs-137 removed from the waste and absorbed onto zeolite ion exchange material is temporarily stored in tank 8D-1 until it can be encapsulated in glass and disposed of as high-level waste. Design of the STS was started in parallel with the selection of the ion exchange material. The construction of this system was accomplished in five phases in parallel with completion of design to allow for faster completion of the project. The existing high-level waste storage tanks (8D-1, 8D-2, and 8D-3) required major renovations to permit transfer of the high-level waste from tank 8D-2 to tank 8D-1, to house the components that comprise the STS in tank 8D-1, and to store the decontaminated waste in tank 8D-3. Testing in the STS started before construction was complete and was accomplished by first testing components individually. Then the system was retested using simulated supernatant. Integrated testing of the whole Integrated Radwaste Treatment System, which includes the STS, Liquid-Waste Treatment System, Cement Solidification System, and the Drum Cell, was also performed using simulated supernatant. Finally, slightly radioactive condensate water from tank 8D-1 was processed. After successfully completing this testing, the STS started operations with radioactive supernatant on May 23, 1988.

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P. Price, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO

**Shallow Groundwater Investigations at Weldon Spring, Missouri**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 141-154) (February 1991)

Investigations at the Weldon Spring site over the past 3 years by the Missouri Department of Natural Resources, Division of Geology and Land Survey, have included classification of stream segments near the Weldon Spring site as gaining (effluent) or losing (influent) segments, locations of springs and other karstic features, water-tracing tests, and identification of upper aquifer recharge areas of key springs. The objective of these investigations is to better define the relationships among surface runoff, groundwater recharge, and shallow groundwater discharge within the study area. Several key springs were identified that may receive recharge from site runoff. This information is being used to design an appropriate groundwater monitoring plan for the Weldon Spring Site Remedial Action Program.

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A.D. Randall, U.S. Geological Survey, Albany, NY

**Induced Changes in the Hydrology at the Low-Level Radioactive Waste Burial Grounds near West Valley, NY**

USGS Circular 1036:24-32

Two low-level radioactive waste sites near West Valley, New York, are situated on slightly sloping shale and siltstone bedrock. Water accumulation in the trenches was an immediate problem, and thus trench design was revised to increase cover over the mounds and separation between the trenches. Infiltration through trench covers has caused rising water levels in the trenches; however, transport of radioisotopes via groundwater is considered negligible.

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R. Reimers, J. Haley, and G. Hampton, Lawrence Berkeley Laboratory, Berkeley, CA

**184-Inch Synchrocyclotron Decommissioning**

CH2669-0/0000-1605; Proceedings of the 1989 Particle Acceleration Conference. Institute of Electrical and Electronic Engineers, New York, NY (1989)

This conference paper is a summary of decommissioning activities performed at the 184-in. synchrocyclotron facility in the Lawrence Berkeley Laboratory (LBL). Design of the 184 was begun in 1940. In 1942, it was first used to electromagnetically separate U-235 from U-238. After the pi zero meson was first discovered at LBL in 1950, most physics experiments involving the 184 were meson-related. Other 184 activities included biophysics experiments to study effects of ionizing radiation on living tissue, pituitary studies, radiotherapy of ocular melanoma, and studies of arteriovenous malformations. Nuclear chemistry studies of fission, spallation, and fragmentation also used the 184. The synchrocyclotron was last run on December 29, 1987. The shutdown freed the site for decommissioning. This report describes the decommissioning work, with separate sections on disassembly, electrical and radiation safety, waste, and industrial safety and hygiene. The decommissioning work included relocation of the Van de Graaf and biomedical programs, radiation measurements, planning, estimate preparation, tooling design and procurement, scheduling, shipping arrangements, rigging studies, obtaining of permits, waste disposal coordination, and cleanup. During decommissioning, all the cyclotron parts and equipment inside the cyclotron cave were found to have induced radioactivity and were disposed of at the U.S. Department of Energy (DOE) Westinghouse Hanford Company site. Shielding blocks were surveyed and core-sampled to determine radioisotope concentrations. They were then segregated for reuse, transfer to other DOE sites, or shipment to landfill. Items outside the shielding were nonactive and contamination free except for a uranium spill on the east floor, which was chipped out and removed along with several inches of the induced floor inside the shielding. Decommissioning waste consisted almost entirely of steel, copper, aluminum, reinforced concrete, and cables, for a total of 8981 tons. Decommissioning was done safely, on budget, and on schedule.

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C.M. Roberts and C.V. Theis, U.S. Geological Survey, Indianapolis, IN

**Preliminary Investigation of Groundwater Occurrences in the Weldon Spring Area, St. Charles County, Missouri**

Report; 36 pp. (December 1951)

At the request of the Atomic Energy Commission, the U.S. Geological Survey conducted an investigation during October 1951 of groundwater occurences in the area of the Weldon Springs Ordinance Works, Weldon Springs, Missouri. During World War II, trinitrotoluene was manufactured on this reservation, which now contains the abandoned processing structures left idle since that time. The purpose of this investigation was to determine the groundwater occurences and subsurface conditions controlling groundwater movement as a prerequisite to the location and design of special structures contemplated by the Atomic Energy Commission. This report contains data gathered from observations of groundwater occurrences, geologic conditions affecting groundwater movement and the structural soundness of rocks.

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D.E. Robertson, C.W. Thomas, N.L. Wynhoff, and D.C. Hetzer, U.S. Nuclear Regulatory Commission, Division of Regulatory Applications, Washington, DC; Pacific Northwest Laboratory, Richland, WA

**Radionuclide Characterization of Reactor Decommissioning Waste and Spent Fuel Assembly Hardware**

NUREG/CR-5343; PNL-6806; 101 pp. (January 1991)

This study is providing the Nuclear Regulatory Commission and licensees with a more comprehensive and defensible data base and regulatory assessment of the radiological factors associated with reactor decommissioning and disposal of wastes generated during these activities. The objectives of this study are being accomplished during a two-phase sampling, measurement, and assessment program involving the actual decommissioning of Shippingport Station and the detailed analysis of neutron-activated materials from commercial reactors. Radiological characterization studies at Shippingport have shown that neutron activation products, dominated by Co-60, comprised the residual radionuclide inventory. Fission products and transuranic radionuclides were essentially absent. Waste classification assessments have shown that all decommissioning materials (except reactor pressure vessel internals) could be disposed of as Class A waste. Measurements and assessments of spent fuel assembly hardware have shown that Ni-63, Ni-59, and Nb-94 sometimes greatly exceed the 10 CFR 61 Class C limit for some components and thus would require disposal in a high-level waste repository. These measurements provide the basis for assessing the disposal options for these types of highly radioactive materials. Comparisons of predicted (calculated) activation product concentrations with the empirical data are providing an assessment of the accuracy of calculational methods. Work is continuing on radiological characterization of spent pressurized water reactor and boiling-water reactor control rod assemblies. Additional work is planned on current issues/problems relating to reactor decommissioning. These efforts will be reported on in future supplements to this report.

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J. Schreiber, U.S. Department of Energy, Shippingport Station Decommissioning Project Office, Shippingport, PA

**Shippingport Station Decommissioning Project Technical Baseline**

CONF-8712101; Maintenance Issues, Proceedings of the ANS International Executive Conference, Orlando, FL, December 6-9, 1987. American Nuclear Society, La Grange Park, IL, 305 pp.; (pp. 1-21) (1987)

This paper discusses the Shippingport Station decommissioning project. The author focuses on the technical baseline requirements: (1) remove radioactive wastes and bury at Hanford, (2) remove reactor pressure vessel and neutron shield tank as a single unit, (3) remove all government owned structures to 3 ft below grade, and (4) release site to owner (Duquesne Light Company) for unrestricted use.

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J.G. Schumacher and K.G. Stollenwerk, U.S. Geological Survey, Washington, DC

**Geochemical Controls on Migration of Molybdenum, Uranium, and Other Constituents at the Weldon Spring Site**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 87-140) (February 1991)

Geologic and geochemical investigations were conducted by the U.S. Geological Survey at the Weldon Spring chemical plant site to determine the potential for migration of molybdenum, uranium, and other constituents from uranium- and thorium-processing wastes (raffinate) disposal pits. Chemical analyses of interstitial water samples and sludge collected at various depths below the water-sediment interface in raffinate pit 3, indicate disequilibrium between the redox species. Nitrate and uranium do not appear to be reduced within the lower part of the sludge in raffinate pit 3 and both are expected to migrate into the overburden beneath the raffinate pits. Laboratory (batch) experiments indicate that significant sorption of molybdenum and uranium occurs within at least two of the overburden units (Ferrelview Formation and clay till) below the raffinate pits. Sorption of molybdenum was controlled by solution pH with complete removal of molybdenum from solutions of less than 5.0. Sorption of uranium was controlled by solution pH and carbonate concentration. Formation of stable uranyl carbonate complexes inhibited sorption of uranium in the clay till. Sorption behavior of both molybdenum and uranium in the overburden units is consistent with sorption controlled by iron oxides. The distribution coefficient model (K sub d) was unable to simulate the experimental data. Sorption of both molybdenum and uranium was successfully modeled using the surface-complexation approach. A comparison of the experimental data and groundwater-quality data indicates preferential migration of weakly-sorbed uranium carbonate complexes with the overburden. The geochemical code PHREEQE was used to identify the source of contamination in a lysimeter near raffinate pit 4. Model simulations indicate that the water quality of this lysimeter can be generated by mixing water from raffinate pits 3 and 4 with an uncontaminated component and allowing for equilibrium with ferrihydrite and calcite.

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C.F. Sigmon and M.B. Levine, Oak Ridge National Laboratory, Oak Ridge, TN

**Environmental Compliance Assessment Findings for Weldon Spring Site Remedial Action Program**

Report; 33 pp. (1990)

This report presents the results of an environmental assessment conducted at Weldon Spring Site Remedial Action Project (WSSRAP) in St. Charles County, Missouri, in accordance with the Formerly Utilized Sites Remedial Action Program Environmental Compliance Checklists. The purpose of this assessment was to evaluate the compliance of the site with applicable federal and Missouri environmental regulations. Assessment activities included the following: review of site records, reports, and files; inspection of the WSSRAP storage building, other selected buildings, and the adjacent grounds; and interviews with the project personnel. The assessment covered five management areas as set forth in the checklist: (1) Hazardous Waste Management; (2) Polychlorinated Biphenyls (PCBs) Management; (3) Air Emissions; (4) Wastewater Discharges; and (5) Petroleum Management. Most of the deficiencies with regard to the regulations addressed by the Environmental Compliance Checklist were administrative. PCB management was the primary area out of compliance with applicable regulations. The only significant finding was the potential for off-site release of PCBs in the event of the failure of tanks located near the Ash Pond. One major deficiency was noted with respect to hazardous waste management: incompatible wastes (corrosive acids and bases) were stored in the same area and were not separated by a wall, berm, or other device. Six minor hazardous waste deficiencies were also noted. One minor deficiency was noted for air emissions, relating to compliance with radionuclide NESHAPs. No deficiencies were noted for either water discharges or petroleum management.

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B. Strisower and R. Spencer, Lawrence Berkeley Laboratory, Earth Sciences Division, Berkeley, CA

**Preliminary Characterization and Assessment of the Weldon Spring Low Level Radioactive Disposal Site, Weldon Spring, Missouri**

LBL-11481; 269 pp. (September 1980)

This report covers the first phase of the characterization and assessment at Weldon Spring, Missouri performed by Lawrence Berkeley Laboratory. This work was done for the U.S. Department of Energy in 1979 and 1980 as the first part of their Remedial Action Plan for the Weldon Spring site and will be completed in 1981. The Weldon Spring Quarry was a U.S. Atomic Energy Commission disposal site for low-level radioactive waste from 1960 to 1969. The quarry is located in highly fractured limestone bedrock and only 200 ft of rock separate the waste from Missouri River alluvial deposits. The purpose of the study is to assess the present extent of contaminant migration, inventory the radioactive waste present at the site, and perform a characterization of the hydrology and geology at the site directed toward predictive analysis. In particular, analysis is geared toward prediction of the future of the site under existing conditions and evaluation of the effectiveness of proposed remedial actions. The tasks under the first phase of work include estimation of the radioactive waste inventory, review of existing data, reoccupying existing wells, drilling new observation wells, alluvium and bedrock core sampling, hydrologic and geochemical monitoring, hydraulic and tracer testing, and development of predictive analytical tools. The immediate radiation hazard appears to be confined to the processed uranium waste piles on the main floor of the quarry. Split spoon samples from auger holes and gamma spectrometric measurements suggest these wastes are dominated by Ra-226 and daughters (at levels of 10-20 curies of Ra-226) and chemically separated uranium in larger amounts. Fracture mapping of the limestone indicates vertical fracture spacing of about 30 ft, and coring shows numerous nearly horizontal fractures. Geophysical logging of boreholes shows elevated uranium levels associated with fractures intersected by wells. Water-level monitoring reveals some large head differences, suggesting that not all fractures are interconnected. The predominant direction of groundwater flow is from north to south. Radiological analysis of alluvium samples taken from boreholes south of the quarry shows substantially elevated levels of uranium, indicating material is leaving the quarry. Hydraulic and tracer tests show much of the groundwater flow is in the limestone bedrock. Preliminary exploratory boring at the Weldon Spring Chemical Plant raffinate pits reveals that the pits are separated from bedrock by about 20 ft of unsaturated silts and clays. No evidence of radionuclide migration has been seen in the pit samples analyzed so far.

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D. Tomasko, Argonne National Laboratory, Environmental Assessment and Information Sciences Division, Argonne, IL

**The Effect of a Zero Concentration Sink on Contaminant Transport and Remedial Action Designs for the Weldon Spring Quarry, Weldon Spring, Missouri**

ANL/EAIS/TM-31; 37 pp. (April 1990)

One-dimensional analytical expressions are developed to simulate two processes in a homogeneous porous medium: contaminant transport through a porous medium that has a zero-concentration sink located at a finite distance from a step-function source, and contaminant transport through a porous medium that has an initial steady-state distribution corresponding to a constant strength source and a zero-concentration sink separated by a finite distance. The governing equations are cast in dimensionless form, making use of the flow system's Peclet number. Evaluation of the analytical expressions is accomplished by numerical inversion of Laplace-space concentrations using either a full Fourier series approach with acceleration or the Stehfest algorithm. The analytical expressions are used to evaluate possible contaminant conditions at the Weldon Spring quarry near Weldon Spring, Missouri. The following results have been found: (1) contaminant concentrations should be at or near steady-state conditions; (2) the spatial distribution of contaminants should be a function of the flow system's Peclet number; (3) contaminant concentrations near the Femme Osage Slough should approach zero; (4) contaminant concentrations near the quarry during dewatering and bulk-waste removal should monotonically decrease with time; and (5) the spatial distribution of contaminants during remedial activities should be relatively flat, especially near the dewatering pumps. Future work will entail evaluating existing radionuclide or chemical concentration data to determine the applicability of the proposed contaminant transport model and to improve the hydrogeological conceptualization of the quarry area and vicinity.

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R.H. Towell, U.S. Department of Energy, Germantown, MD

**Certifying the Decommissioned Shippingport Reactor Vessel for Transport**

Regulatory Philosophy and Intent of Radioactive Material Transport Including Transport of Components from Decommissioned Nuclear Facilities, Proceedings of the 1990 Pressure Vessels and Piping Conference, Nashville, TN, June 17-21, 1990. American Society of Mechanical Engineers, New York, NY; (pp. 43-46) (1990)

The decommissioned Shippingport reactor pressure vessel with its concentric neutron shield tank was shipped to Hanford, Washington as part of the effort to restore the Shippingport Station to its original condition. The metal walls of the reactor vessel had become radioactive from neutron bombardment while the reactor was operating, so it had to be shipped under the regulations for transporting radioactive material. Because of the large amount of radioactivity in the walls (16,467 curies), and because the potentially dispersible corrosion layer on the inner walls of both tanks was also radioactive, the Shippingport reactor vessel was transported under the most stringent of the regulations, those for a Type B package. Compliance with the packaging regulations was confirmed via independent analysis by the staff of the U.S. Department of Energy (DOE) Certifying Official, and the Shippingport reactor vessel was shipped under DOE Certificate of Compliance USA/9515/B(U).

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U.S. Department of Energy, Assistant Secretary for Environment, Safety, and Health, Washington, DC

**Finding of No Significant Impact - Decontamination and Decommissioning of**

**Battelle Columbus Laboratories in Columbus and West Jefferson, Ohio**

DOE/EA-0433; 75 pp. (1990)

This environmental assessment has been developed by the U.S. Department of Energy (DOE) in accordance with the requirements of the National Environmental Policy Act of 1969 for the proposed decommissioning of contaminated areas at the Battelle Memorial Institute, Columbus, Ohio. The discussions in Section 1.0 provide general background information on the proposed action. Section 2.0 describes the existing radiological and nonradiological condition of the Battelle Columbus Laboratories. Section 3.0 identifies the alternatives considered for the proposed action and describes in detail the proposed decommissioning project. Section 4.0 evaluates the potential risks the project poses to human health and the environment. Section 5.0 presents DOE's proposed action. As a result of nuclear research and development activities conducted over a period of approximately 43 years performed for DOE, its predecessor agencies, and under commercial contracts, the 15 buildings became contaminated with varying amounts of radioactive material. DOE no longer has a need to utilize the facilities and is contractually obligated to remove contamination such that the buildings can be used by the owners without radiological restrictions. This environmental assessment for the Battelle Columbus Laboratories Decommissioning Project is consistent with the direction from the Secretary of Energy that public awareness and participation be considered in sensitive projects and is an appropriate document to determine action necessary to satisfy the requirements of the National Environmental Policy Act.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**Decontamination and Decommissioning Facility Environmental Assessment: Feed Materials Production Center, Fernald, Ohio**

DOE/EA-0333; 106 pp. (August 1988)

The Feed Materials Production Center (FMPC) is a U.S Department of Energy (DOE) uranium-metal production facility located near Fernald, Ohio. Currently under management of the Westinghouse Materials Company of Ohio, FMPC has been in operation since 1954. Its primary mission is the production of purified uranium metal and uranium compounds for use at other DOE defense facilities. A small amount of thorium processing has also been conducted. Operations at FMPC result in radioactive contamination of tools, scrap materials, equipment, and vehicles used in material transport. At present, only a small decontamination and decommissioning (D&D) facility built in the 1950s is in operation at FMPC. It uses outdated technologies and is inadequate to handle current and future needs in an environmentally safe manner. DOE proposes that the preferred solution is to construct a new D&D facility at FMPC as part of the Environmental, Health, and Safety Improvements project. This report describes the proposed facility in detail, including site preparation, physical description, process description, waste-handling systems, and quality control. The facility will contain areas for equipment breakdown, high-pressure water spray for washing vehicles and large pieces of equipment, freon and ultrasonic cleaning, abrasive grit-blasting, and a staging-out area for radiation surveys. Three alternate plans are also described: (1) upgrading the existing D&D facility, (2) transporting contaminated material off-site, and (3) no action. The environment of the area is described, and environmental consequences of the proposed facility and the alternate plans are assessed.

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U.S. Department of Energy, Washington, DC

**Environment, Safety and Health, Management and Organization Compliance Assessment, West Valley Demonstration Program, West Valley, New York**

DOE/EH-0114; 424 pp. (August 1989)

An Environment, Safety and Health Tiger Team Assessment was conducted at the West Valley Demonstration Project (WVDP). The Tiger Team was chartered to conduct an on-site, independent assessment of the WVDP environment, safety, and health (ES&H) programs to ensure compliance with applicable federal and state laws, regulations, and standards, and U.S. Department of Energy (DOE) orders. The objective is to provide to the Secretary of Energy the following information: current ES&H compliance status of each facility; specific noncompliance items; root causes for noncompliance items; evaluation of the adequacy of ES&H organization and resources (DOE and contractor) and needed modifications; and, where warranted, recommendations for addressing identified problem areas.

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U.S. Department of Energy, Washington, DC

**Verification and Certification Protocol for Remote Sites Decontaminated Under the Surplus Facilities Management Program**

Report; 22 pp. (January 31, 1986)

This protocol outlines procedures for verifying, certifying, and documenting for the public record that remedial actions performed by the Surplus Facilities Management Program (SFMP) on remote sites comply with applicable radiological guidelines. Remote sites are defined as facilities/properties owned by the U.S. Department of Energy (DOE) which are not located on a major DOE site. Responsibility for the technical conduct of the verification and certification process rests with the individual DOE field office and its subcontractors, to whom an SFMP project is assigned. The SFMP Office is responsible for making recommendations to DOE-Headquarters regarding final approval of the certification docket and shall provide overview of the field offices to ensure consistency with this protocol. The verification and certification process consists of three activities to be implemented by the field office: (1) remedial action measurements - site radiological data collected and analyzed during the project; (2) independent verification - confirmation by an unbiased, independent party of the accuracy and validity of the field measurements and procedures used in the remedial action; and (3) certification docket - formal documentation, review, finalization, and making public a record of the verification and certification process.

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U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, MO

**Weldon Spring Site Remedial Action Project Update**

WSSRAP Update (901100):1-8 (November 1990)

This document provides a general update of activities at the Weldon Spring Site Remedial Action Project (WSSRAP) through November 1990. Major articles in this issue are (1) Argonne National Laboratory Serves WSSRAP; (2) Chemical Incident Emphasizes Total Safety Awareness; (3) New Water Tower Planned; (4) Two Meetings Held to Obtain Input for Cleanup Plans; (5) Procurement Held Open House for Contractors; (6) WSSRAP Goes Fishing; (7) Waste Water Treatment Systems; and (8) Steve McCracken Appointed DOE Site Project Manager.

**88**

U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, MO

**Changes on Weldon Springs Horizon**

WSSRAP Update 3(1):1-8 (May 1991)

This newsletter is published semiannually by the Weldon Springs Site Remedial Action Project (WSSRAP) in Missouri for the people of St. Charles County. This issue was distributed as an advertising insert in the Sunday (May 5) St. Charles Journal. Articles in this issue cover (1) the beginning of cleanup at the Weldon Spring Quarry, (2) dismantling of buildings at the site, (3) a schedule of WSSRAP activities for 1991, (4) local volunteer education program participation by WSSRAP personnel, (5) the WSSRAP Geosciences Seminar on February 21, 1991, (6) program management personnel changes, and (7) HAZMAT training for 10 area emergency response teams at WSSRAP.

**89**

U.S. Department of the Army, Office of Department of Army Project Manager for

Chemical Demilitarization and Installation Restoration, Aberdeen Proving Ground, MD

**Assessment of Weldon Spring Chemical Plant in St. Charles County, Missouri**

Report; 174 pp. (1976)

This 1976 report contains the Department of the Army's general assessment of the Weldon Spring chemical plant in St. Charles, Missouri. Included in the report are a detailed site description, a history of the plant, a geological/hydrological assessment of the plant and surrounding areas, assessment of radiological and explosives contamination, and U.S. Energy Research and Development Administration plans for the plant.

**90**

Westinghouse Hanford Company, Richland, WA

**Lifting, Barge Loading, and Transportation of the Shippingport Reactor Pressure Vessel Package - Topical Report**

DOE/SSDP-0079; 44 pp. (November 28, 1989)

This report is a synopsis of the removal of the Shippingport Station reactor pressure vessel (RPV) package and its subsequent shipment to the burial site on the Hanford Reservation in southeastern Washington. This report describes the initial management decisions, engineering requirements, operations, schedule performance, equipment, and lessons learned. Selected photographs of the RPV and neutron shield tank lift and transportation activities are provided in the text, where appropriate. The lifting and transportation of the RPV package was significant in that it demonstrated a viable alternative to segmentation for the removal of large RPVs. Schedule performance was less than initially planned because of delays incurred by the subcontractor and a decision made by the U.S. Department of Energy. However, there was no significant impact to the project. The lifting, barge loading, and transportation of the RPV was a fixed-price, competitively-bid subcontract awarded to Williams-Bragg Joint Venture. The original contract price was $4,872,059. Because of the delayed shipment of the package and additions to the scope, the work was completed for $5,904,462.

**91**

J.H. Williams, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO

**Weldon Spring Area Investigations, St. Charles County, Missouri**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 1-6) (February 1991)

The state of Missouri Department of Natural Resources, Division of Geology and Land Survey (DGLS) has conducted geologic and hydrologic investigations in the Weldon Spring area since 1955. Early studies mapped the area; described the bedrock formations, water resources, and soil materials; and investigated geological conditions at lake sites and raffinate pit sites. Since 1974, DGLS has investigated the integrity of the raffinate pits, especially Pit 4, and proposed remedial measures. In the first decade, studies by consultants have resulted in explicitly descriptive reports and realistic appraisals of the suitability of the site for waste disposal. DGLS has used dye trace studies to refine understanding of subsurface geologic features.

**92**

M.J. Wilson and J.W. Crutcher, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of the Independent Verification of Radiological Remedial Action at 600 South Clayhill Drive (AKA 600 South Cemetery Road), Monticello, Utah (MS00145)**

ORNL/RASA-91/3; 7 pp. (July 1991)

In 1980, the site of a vanadium mill at Monticello, Utah, was accepted into the U.S. Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1986 and 1987, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 600 South Cemetery Road (updated by San Juan County and the State of Utah to 600 South Clayhill Drive), Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described.

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M.J. Wilson and J.W. Crutcher, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of the Independent Verification of Radiological Remedial Action at 464 South 1st East Street, Monticello, Utah (MS00071)**

ORNL/RASA-91/4; 7 pp. (July 1991)

In 1980, the site of a vanadium mill at Monticello, Utah, was accepted into the U.S. Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1986 and 1987, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 464 South 1st East Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described.

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M.J. Wilson and J.W. Crutcher, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of the Independent Verification of Radiological Remedial Action at East 5th South Street, Monticello, Utah (MS00075)**

ORNL/RASA-91/5; 7 pp. (July 1991)

In 1980 the site of a vanadium mill at Monticello, Utah, was accepted into the U.S. Department of Energy's (DOE's) Surplus Facilities Management Program, with the objectives of restoring the government-owned mill site to safe levels of radioactivity, disposing of or containing the tailings in an environmentally safe manner, and performing remedial actions on off-site (vicinity) properties that had been contaminated by radioactive material resulting from mill operations. During 1986 and 1987, UNC Geotech, the remedial action contractor designated by DOE, performed remedial action on the vicinity property at 16 East 5th South Street, Monticello, Utah. The Pollutant Assessments Group (PAG) of Oak Ridge National Laboratory was assigned the responsibility of verifying the data supporting the adequacy of remedial action and confirming the site's compliance with DOE guidelines. The PAG found that the site successfully meets the DOE remedial action objectives. Procedures used by PAG are described.

95

J. Wood

**Cost Lessons Learned from Decommissioning Shippingport**

Nuclear Engineering International 35(434):20-22 (September 1990)

The U.S. Department of Energy has completed decommissioning of its 72 MW(e) Pressurized Water Reactor at Shippingport. The project, finished on time and under budget, should be encouraging for utilities preparing to decommission commercial plants. But the real lesson of the Shippingport project is that commercial decommissioning of the much larger reactors now in operation will be more difficult and more expensive.

**96**

D.M. Yannitell, General Electric Company, Decommissioning Operations Contractor for SSDP, Shippingport, PA

**Radiological Release Programs for Nuclear Decommissioning Projects**

DOE/SSDP-0077; CONF-891002; Proceedings of the American Society of Mechanical Engineers Joint Power Generation Conference, Dallas, TX, October 22-26, 1989; (3 pp.) (October 29, 1989)

One of the key factors affecting the cost of decommissioning a nuclear facility is the establishment of a radiological release program, which is often neglected during the planning and cost estimating phase of a decommissioning project. Costs associated with radioactive waste management (i.e. removal, volume reduction, packaging, shipment, and burial) and with nonradioactive waste management (which includes conducting surveys and preparing documentation for unconditional release) are affected by release criteria established and the methodology used to demonstrate compliance. There are four elements that comprise the radiological release program: (1) criteria for unconditional release of material to be moved off-site, (2) methodology for demonstrating compliance with the off-site release criteria, (3) criteria for unconditional release of material to remain on-site, and (4) methodology for demonstrating compliance with the on-site release criteria. Only one of the four elements is defined by federal regulations and that one is incomplete. U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 provides criteria for unconditional release of material off-site, but cannot be directly applied to porous materials or materials with inaccessible surfaces. Items 2, 3, and 4 above have not been established by either the U.S. Environmental Protection Agency or the U.S. Nuclear Regulatory Commission. The Shippingport Station Decommissioning Project radiological release program elements are discussed. A discussion is also included of the financial sensitivity to variables within the program.

# NUCLEAR FACILITIES DECOMMISSIONING

97

E. Aalto, T. Kukkola, and E. Mayer, Imatran Voima Oy, Helsinki, Finland

**Finns Plan to Take Loviisa Main Components Out Intact**

Nuclear Engineering International 35(434):33-35 (September 1990)

As part of the decommissioning plans for the VVER pressurized water reactors at Loviisa, Finland, it is intended to remove the pressure vessel, steam generators and pressurizer intact to the final repository. The pressure vessel itself will be used as a waste package for the most active parts of the plant.

98

**After the Fire: Preparing the Windscale Piles for Decommissioning**

Nuclear Engineering International 35(431):48-49 (June 1990)

The Windscale Piles in the United Kingdom were taken out of service in 1957 after a fire in Pile 1. They have remained essentially in the same state since that time and during this period there have been periodic inspections of the complete structures to ensure that there is no degradation taking place. The piles are in a safe condition and would remain so for a considerable period (50 years or more) provided they were undisturbed. However, the piles must be decommissioned at some time and clearly this will require the preparatory work that is now underway. The work is scheduled for completion in 1994, at a cost of 8 million British pounds at present-day prices.

99

R.P. Allen, G.J. Konzek, K.J. Schneider, and R.I. Smith, Pacific Northwest Laboratory, Richland, WA

**Assessment of Foreign Decommissioning Technology with Potential Application to U.S. Decommissioning Needs**

PNL-6335; 62 pp. (September 1987)

This study was conducted by the Pacific Northwest Laboratory for the U.S. Department of Energy to identify and technically assess foreign decommissioning technology developments that are improvements over decommissioning technology currently available or under development in the United States. Specific technological needs for nuclear power decommissioning operations were identified and prioritized using the results of past light water reactor (LWR) decommissioning studies. These studies were used to quantitatively evaluate the potential for reducing cost and worker-radiation-dose for each major decommissioning activity. Based on the identified needs, foreign decommissioning technologies of interest were identified through personal contacts and the collection and review of decommissioning literature. The foreign technologies were then qualitatively assessed for uniqueness, potential for cost reduction, worker-radiation-dose reduction, development status and other factors relative to U.S. needs. The results of the study show that the elements with the greatest potential for cost savings in LWR decommissioning are (1) management of radioactive decommissioning wastes; (2) demolition of heavily reinforced nonradioactive structures; and (3) detachment, removal, and segmentation of fluid systems and components. Worker radiation dose data show that technology improvement in element (3) is the major opportunity for the reduction of worker doses. The study indicates that the many of the fully developed foreign technologies applicable to these needs are now available in the U.S. However, extensive foreign research and development (R&D), demonstration, and application of the technologies represent a valuable source of information on costs, waste volumes, adaptations, etc., beneficial for U.S. decommissioning efforts. In addition, several foreign technologies in the conceptual, R&D, or demonstration stages that should be monitored and periodically reassessed are listed.

100

American Society for Testing and Materials, Philadelphia, PA

**Standard Guide for Radioactive Pathway Methodology for Release of Sites Following Decommissioning**

1989 Annual Book of ASTM Standards Section 12, Volume 12.0 - Nuclear (II), Solar and Geothermal Energy - Designation: E 1278 - 88; (pp. 811-816) (February 1989)

The purpose of this guide is to provide assistance in determining site-specific conversion factors for translating between dose limits and residual radioactive contamination levels on equipment, structures, and land areas. This guide does not endorse specific levels of allowable residual radioactive contamination, nor does it provide a methodology for population dose calculation. Standards prescribing dose limits for decommissioned nuclear facilities or sites and/or private properties contaminated with radioactive materials are necessary to identify decommissioning methods, guide cleanup (remedial action) efforts, determine cleanup costs, identify the amount of radioactive waste to be disposed, and protect the public. Such standards, however, are not yet available for all types of nuclear facilities, sites, or properties. Regulatory Guide 1.86 of the Nuclear Regulatory Commission, as well as specific promulgations of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, provide some specific guidance. This guide is not intended to establish these federal policies; they will be promulgated by EPA and other federal agencies. Rather, it is to serve as a guide to acceptable methodology for translating the yet-to-be-determined dose limits into allowable levels of residual radioactive materials which can be left at a site following decommissioning. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

101

M.J. Angus, S.R. Hunter, and J. Ketchen, United Kingdom Atomic Energy Authority, Windscale Nuclear Laboratories, Sellafield, Seascale, Cumbria, United Kingdom

**Classification of Contaminated and Neutron-Activated Concretes from Nuclear Facilities Prior to Their Decontamination or Decommissioning**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 229-234) (1990)

A good estimate of the radioactivity in a nuclear facility is required to define the approach to decommissioning in terms of method and timing. A series of concrete core samples have been taken from various aging nuclear facilities. These include a cooling pond, a dry concrete facility and a reactor bioshield. These samples have been examined to determine radiation levels, distribution of surface activity, depth of penetration of specific radionuclides, compressive strength, and some microstructural examination by a scanning electron microscope. The results will provide useful information in planning decommissioning. Although activity can penetrate some distance into the concrete, the levels are very low compared to surface activity. The amount of penetration depends on the surface condition of the concrete.

102

M. Anttila, Technical Research Centre of Finland, Nuclear Engineering Laboratory, Loviisa, Finland

**Activity Inventory of the Biological Shields of the Loviisa Nuclear Reactors**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (23 pp.) (June 1991)

As part of decommissioning studies of the Loviisa nuclear power plant [consisting of two 465 MW(e), VVER-440-type pressurized water reactors], the activity inventory of the biological shields of the units has been estimated using updated material gain. The activation and subsequent cooling have calculated with the ORIGEN-S program. The irradiation fluxes have been estimated with the ANISN transport code using cross-sections taken from the BUGLE-80 data library. The results of the ORIGEN-S calculations seem to agree with other studies. In case of a prompt dismantling, the most important radionuclides in the Loviisa bioshields are Fe-55, Co-60, H-3, and Ni-63. The long-term effects will be determined by Ca-14 and, to a smaller extent, by Ni-59, C-14, Cl-36, and Ar-39.

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W. Bach, H. Haferkamp, L. Mensching, D. Stegemann, and H. Steiner, Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn, Federal Republic of Germany; Hannover University, Institute fuer Kerntechnik, Federal Republic of Germany

**Radiological Safety Aspects of Dismantling and Breakdown Methods - Thermal Breakdown**

CONF-8611297 (Vol. 11); Radiation Protection Principles for Management of Solid Radioactive Waste, Proceedings of a Closed Meeting of the Strahlenschutzkommission, Gundremmingen, Federal Republic of Germany, November 6-7, 1986, Vol. 11, 223 pp.; (pp. 123-135) (1988)

All three stages of decommissioning require dismantling and cutting work. Because of the high radiation absorption capacity of water and the washdown effect (which reduce the release of radioactivity into the atmosphere during cutting work), the primary loop components of a reactor are dismantled and cut into pieces using underwater methods. Other components like the biological shield are dismantled in normal atmosphere. For breakdown and cutting work, mechanical, electrochemical, or thermal means have their specific advantages or drawbacks with regard to the material to be cut, which is usually austenitic steel, ferritic steel with austenitic plating, or concrete. Compared with mechanical methods, the thermal cutting techniques have advantages such as freedom of resilience, high cutting speed, flexible cutting pathway, and good manipulation in case of nonplane structural components.

104

W.A. Bair, Ebasco Services, Inc., New York, NY

**Decontamination/Decommissioning of the Princeton Pennsylvania Accelerator Facility**

Excellent and Economic Nuclear Plant Performance, S.R. Penfield Jr. (ed.), Proceedings of the Combined ANS Power Division Topical Meeting and ASME Nuclear Energy Conference, Newport, RI, September 16-19, 1990. American Society of Mechanical Engineers, New York, NY, Vol. 4; (p. 95) (1990)

The Princeton Pennsylvania Accelerator (PPA) Facility was a 3-GeV proton synchrotron operated jointly by Princeton University and the University of Pennsylvania from 1962 to 1972 on the Princeton University Forrestal Campus. During synchrotron operations, certain portions of the PPA central accelerator chamber and structural members became neutron activated. Upon termination of accelerator operations because of funding problems, Princeton desired to utilize the PPA site for other purposes, and commissioned a study to investigate decommissioning and decontamination (D&D) options and methodologies. The study investigated several methods for in-place, surgically removing the neutron activated from uncontaminated concrete. Since each technique produced different volumes of removed concrete (e.g., concrete rubble versus dense cut blocks), all methods investigated were studied from the total economics of the problem (removal, handling, packaging, transport, and burial costs) and the costs of limiting and cleanup of secondary contamination. The decontamination method selected used a diamond-wire cutting technique to sever in-place, the activated concrete from the uncontaminated. Large, intact, activated structural segments were cut and removed from the central accelerator chamber floor, outer walls, internal columns, and ceiling. Nonactivated portions of the structure, and the remainder of the central chamber were subsequently razed by conventional demolition methods. The paper describes the decontamination methodology, its effectiveness, disposal economics, and radiological safety problems related thereto.

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K.P. Ballard, M.E.C. Everett, and W.C. Everett, Pacific Gas & Electric Company, San Francisco, CA

**Utilities and Decommissioning Costs: The Meeting of Technology and Society**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 3; (pp. 29-41) (1991)

Nuclear energy policy is affected by a myriad of groups, including regulatory agencies, public interest organizations, private businesses, and academic research groups. As policy bends and changes, no group is affected more strongly than public utility companies. The main reason for such sensitivity is that the utility companies, more than any of the other players in the utility business, are the link between technology and society. This chapter presents the utility view of decommissioning within the context of Pacific Gas & Electric's nuclear power stations at Diablo Canyon and Humboldt Bay. The discussion includes special utility problems, such as inherent uncertainties and the causes for overestimating and underestimating. Among the conclusions is that the overall discussion of decommissioning technology is developing outside the commercial marketplace and will likely lead to inefficiencies, and that the various social costs and ramifications of decommissioning need much more attention.

106

A. Barbe and R. Pech, Compagnie Generale des Matieres Nucleaires, Velizy Villacoublay, France; SGN, Cedex, France

**Cost Estimation of the Decommissioning of Nuclear Fuel Cycle Plants: Application to Reprocessing Plants**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 629-634) (1990)

Most studies conducted to date on the cost of decommissioning nuclear facilities pertain to reactors. Few such studies have been performed on the cost of decommissioning nuclear fuel cycle plants, particularly spent-fuel reprocessing plants. Nevertheless, present operators of these plants need to assess the magnitude of such costs, at least to include the related expenses in their short-, medium- or long-term projections. They also need to determine now, for example, suitable production costs that the plant owners will have to propose to their customers. Unlike nuclear reactors for which a series effect is involved and where radioactivity is relatively concentrated, industrial-scale reprocessing plants are large, complex installations for which decommissioning is a long and costly operation that requires a special approach. Faced with this problem, Cogema, the owner and operator of the La Hague and Marcoule reprocessing plants in France, called on SGN to assess the total decommissioning costs for its plants. This assessment led to development by SGN engineers of a novel methodology and a computerized calculation model, which are described. The resulting methodology and model are applicable to other complex nuclear facilities besides reprocessing plants.

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C. Beck-Dudley and R. Malko, The Forum Limited, Milwaukee, WI

**Decommissioning Nuclear Power Plants: A Survey of State Public Service Commissions**

Journal of Energy Law & Policy (1990)

This paper discusses the legal, technological, financial, and regulatory issues involved in the decommissioning of nuclear power plants.

108

C. Bergman and S. Menon, National Institute of Radiation Protection, Stockholm, Sweden; Nordisk Kontaktorgan for Atomenergispoergsmaal, Risoe, Denmark; Studsvik Nuclear, Nykoeping, Sweden

**Some Studies Related to Decommissioning of Nuclear Reactors**

NORD-1990-30; 58 pp. (February 1990)

Decommissioning of large nuclear reactors has not yet taken place in the Nordic countries. Small nuclear installations, however, have been dismantled. This Nordic Liason Committee for Atomic Energy (NKA) program has dealt with some interesting and important factors which have to be analyzed before a large scale decommissioning program starts. Prior to decommissioning, knowledge is required regarding the nuclide inventory in various parts of the reactor. Measurements were performed in regions close to the reactor tank and the biological shield. These experimental data are used to verify theoretical calculations. All radioactive waste generated during decommissioning will have to be transported to a repository. Studies show that in all the Nordic countries there are adequate transport systems with which decommissioning waste can be transported. Another requirement for orderly decommissioning planning is that sufficient information about the plant and its operation history must be available. It appears that if properly handled and sorted, all such information can be extracted from existing documentation.

109

F. Berkhout, Science Policy Research Unit, London, United Kingdom

**The Management and Regulation of Decommissioning Wastes**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 4; (pp. 59-84) (1990)

Radioactive waste management is an inevitable consequence of nuclear technology. In the past it was often regarded as a peripheral matter, easily dealt with and having little impact on the economics of the fuel cycle. Gradually, over the last two decades, waste management has asserted itself as one of nuclear power's most intractable problems. First, it is a problem of trying to understand through science the effects of discharging and disposing of man-made radioactivity to the general environment. Second, technologies for treating and disposing of the wastes, as well as techniques to verify their safety, must be developed. Third, and most problematically, a wide-spread public trust in the techniques of management must be nurtured. Disputes over each of these dimensions exist in nearly all countries with nuclear programs. Some of them may be near resolution, but many others are far from closure. Decommissioning, because it comes last in the nuclear life-cycle, is also the last important aspect of the technology to be considered seriously. In Britain, wastes arising from decommissioning, whether it is done slowly or quickly, are projected to have an important impact on the scale of radioactive waste management programs, beginning in the mid-1990s. It follows that decommissioning, contentious in itself, is likely to exacerbate the difficulties of waste management.

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D.E. Bernhardt, D.H. Owen, S.V. Prewett, and L.W. Cole, Rogers and Associates Engineering Corporation, Salt Lake City, UT; GenCorp, Fairlawn, OH; Aerojet Ordnance Tennessee, Inc., Jonesboro, TN

**Unrestricted Release of a Depleted Uranium Manufacturing Facility**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 571-576) (March 1989)

Aerojet Ordnance completed successful decontamination, with termination of license, of its depleted uranium manufacturing facility in Compton, California, in June 1988. Reconstruction was completed, and the facility was released six weeks after the final closeout radiological survey. Aerojet leased the facility in 1977 and conducted manufacturing and research and development activities in the structure until mid 1986. Operations were performed under a state of California Radioactive Source Materials License. The facility is a 6000 sq m warehouse-type building located in a commercial area. Decontamination of the facility was performed under an amendment to the operating license, with inspections and oversight similar to that for the operating license. This paper reviews the planning and preparations for the closure of the facility, then focuses on the decontamination operations and the project planning that brought about full unrestricted release of the facility and termination of the radioactive source material license.

111

S.C. Bhatia, Bhabha Atomic Research Centre, Process Engineering and Systems Division, Bombay, India

**Decommissioning and Decontamination Studies for Nuclear Facilities**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (24 pp.) (June 1991)

Studies have been carried out at Bhaba Atomic Research Center in India in various areas of decontamination and decommissioning. Laboratory studies have been performed on the dissolution characteristics of synthetic crud powders in a variety of chemical combinations. Experiments were also carried out with the cationic and anionic exchangers toward removal of metallic species and of organics as spent decontamination reagents. Pilot-scale loop studies have been conducted to understand the dynamic behavior of the prospective decontamination formulations as evolved in the preliminary laboratory tests. Electrochemical parameters were established for stainless steel specimens in a small electropolishing setup. A computerized data base was created on the gross decontamination data obtained during a plant-scale decontamination campaign in a radiochemical facility. Progress made in these areas of work are described in this report.

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B. Biewald and S. Bernow, Tellus Institute, Boston, MA

**Confronting Uncertainty: Contingency Planning for Decommissioning**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 18; (pp. 233-246) (1991)

The experience of nuclear power plant construction costs, schedule delays, post-operational costs, and performance problems should provide a warning to planners who are confronted with decommissioning funding decisions. Nuclear power projects generally and specifically begin with high optimism; but ultimately they experience rate increases, significant retrofits, problematic performance, and much litigation. Plans for decommissioning typically include one or more of the following overly optimistic assumptions: (1) that radioactive waste disposal costs will not increase beyond current levels, (2) that regulations will remain unchanged, (3) that significant surprises will not emerge during the decommissioning process, and (4) that the plants will operate for the full duration of their operating licenses. Given the uncertainties inherent in each of these assumptions, it seems certain that for most plants the actual decommissioning costs will be far greater than present estimates. Continued reliance upon future updates as a solution to this problem is likely to lead to funding shortfalls and possible ensuing public health and safety problems. Planners should allow for various types of contingencies when estimating decommissioning costs if the objective of providing adequate funds for successful decommissioning is to be accomplished.

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U. Birkhold, Noell GmbH, Wuerzburg, Federal Republic of Germany

**Decommissioning of the Niederaichbach Power Plant**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 189-195) (April 1990)

Decommissioning of nuclear facilities involves a number of economic and technical problems, including safety and approval problems, radiation shielding measures, handling and dismantling of large activated components, decontamination methods, and release of resultant material. These and other issues were studied during the decommissioning of the nuclear power plant in Niederaichbach (KKN), Federal Republic of Germany. KKN is a good subject for study because of its relatively small activity inventory and because the plant was shut down in 1974 and has already been transferred to a "safe enclosure" condition. Demolition is planned to progress in two phases. Phase 1 includes the preparations leading to the start of on-site work such as project and planning work, approval procedure, and construction and fabrication of specialized tools and manipulators. Phase 1 was completed in June 1987. Phase 2 covers the on-site dismantling work and will be finished when a "green field" condition is achieved. Phase 2 started in July 1987 and will be finished in the middle of 1994.

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J. Blazek, M. Solcanyi, D. Majersky, and F. Krejci, Nuclear Power Plant Research Institute, Jaslovske Bohunice, Czechoslovakia

**Chemical and Electrochemical Decontamination for Decommissioning of Nuclear Power Plants**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (12 pp.) (June 1991)

Development of economic processes for chemical and electrochemical decontamination of stainless and mild steels from the Nuclear Power Plant A-1 Reactor at Jaslovske Bohunice (NPP A-1), for unrestricted release of the metals and verification of these processes under pilot-plant conditions is one of the objectives of Nuclear Power Plant Institute's program. Previous paper and laboratory experiments showed that decontamination of carbon steels from NPP A-1 is very successful in a solution composed of formic acid-complexing agent (EDTA, EDTANa2, EDTANa4) corrosion inhibitor (solution further called FEDTA) under simultaneous action of ultrasound. Efficiency of postdismantling decontamination of carbon steels in FEDTA solution under simultaneous action of ultrasound was, therefore, verified under pilot-plant conditions. The equipment consists of a stainless steel tank with solution pump, solution heating elements, steam removal system, and three ultrasonic emitters on the tank bottom. Decontamination can be carried out by putting particular pieces of material directly into the tank or into a basket in the tank.

115
A. Blowers, Durham University, Durham, United Kingdom

**Generations of Decay: the Political Geography of Decommissioning**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 9; (pp. 161-173) (1990)

Energy is politics. We rarely find it where we need it, it imposes upon other areas when we move it, and the less control we have over its development and use the more politically insecure we feel. Nuclear power appears to avoid the traditional politics of energy supply by geographically internalizing much of the fuel cycle. But the problem of waste disposal, including decommissioning, is a major source of political conflict and uncertainty affecting the whole future of the nuclear industry. One of the most politically motivated decisions of the decommissioning era will be in choosing whether the process will be immediate or deferred. Deferred decommissioning is the most likely strategy, and geographical inertia is the likely outcome. Such inertia is a feature of industrial decline, with each industrial epoch leaving the detritus of past decisions for future generations to discover and deal with. The political basis of the nuclear fuel cycle is its links with considerations of wastes, hazards, longevity, and equity, all matters of public interest and concern. As part of the nuclear fuel cycle, decommissioning will include these considerations too, and it is for this reason that wherever decommissioning takes place political questions arise.

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H.J.C. Boekschoten, Keuring van Electrotechische Materialen, Arnhem, Netherlands

**Dismantling of Nuclear Power Plants**

Energiespectrum 14(3):83-87 (March 1990)

One of the most important discussion points with regard to the question of extending the Dutch nuclear-power program is the possibility for dismantling nuclear power plants at the end of their operation time. Full dismantling of a large nuclear power plant, as will have to be done also in Western Europe, has thus far not been demonstrated. However, technology is progressing so much that no large technical difficulties are expected. In some countries dismantling is delayed because no final destination for the radioactive dismantling wastes exists.

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T. Boorman, D.J. Ashcroft, E.H. Perrott, N.W. Collins, and P.K. Smith, United Kingdom Atomic Energy Authority, Windscale Nuclear Laboratories, Sellafield, Seascale, Cumbria, United Kingdom; Strachan and Henshaw Limited, Bristol, United Kingdom; Taylor Hitec Limited, Chorley, United Kingdom

**How to Decommission a Nuclear Reactor, Efficiently and in Complete Safety, from the Inside Outwards**

Nuclear Engineer 30(4):114-119 (1989)

This paper describes the background and development to final concept of the remote dismantling machine system being used in the decommissioning of the Windscale Advanced Gas-Cooled Reactor (WAGR) in Sellafield, United Kingdom. It further examines the design and implementation of the system's cutting and gripping workheads. The decommissioning project is approaching the stage where the dismantling can only progress by the used of remotely controlled cutting and handling equipment. The structure of the reactor itself, which includes a steel pressure vessel, graphite core, and concrete biological shield has become activated by the intense neutron flux during its 18 years of operation. This means that all operations to remove this radioactive structure must be carried out within shielded enclosures to control the radiation exposure of the dismantling team. The project is managed by the United Kingdom Atomic Energy Agency (UKAEA) Northern Research Laboratories, Windscale. The design work is carried out by the UKAEA Engineering Division of Risley Technical Services. To provide the equipment, contracts have been placed with Strachan and Henshaw Limited for the main machine and with Taylor Hitec Limited for a robot manipulator created specifically for the WAGR decommissioning task.

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R.W. Bowser, D.R. Keuter, and K.R. Miller, Sacramento Municipal Utility District, Sacramento, CA

**Spent Fuel Storage: A Decommissioning Perspective**

Journal of Nuclear Materials Management 19(2):13-16 (May 1991)

On June 6, 1989, the public voted to recommend that the Sacramento Municipal Utility District no longer operate Rancho Seco Nuclear Generating Station as a nuclear power plant (although the vote did not prohibit sale to or operation by a qualified operator). The original 10 CFR 50 operating license for the station expires in the year 2008. Plant operators shut down the plant on June 7, 1989. Reactor defueling was subsequently completed on December 8, 1989. A total of 493 fuel assemblies are now stored in the Spent Fuel Pool in the Fuel Storage Building at the station. Although the premature decommissioning of Rancho Seco presents some unique problems regarding the management of spent fuel, the utility district's decisions and lessons learned may benefit all facilities facing eventual decommissioning. A review from this perspective, done well before plant decommissioning begins, can be integrated into the decision making process of an operating nuclear power plant. To close and ultimately decommission Rancho Seco as safely and economically as possible, the utility district developed objectives to support the related disposition of the spent fuel: (1) minimize occupational and public radiation exposure; (2) minimize decommissioning costs, including the need to maintain the spent fuel pool; and (3) prepare the fuel for DOE acceptance. The utility district plans to use dual-purpose (combined storage/transport) casks to meet these objectives. This plan is contingent upon a successful DOE demonstration program that will resolve any outstanding Nuclear Regulatory Commission issues and provide evaluation sufficient to permit licensing of existing large DOE-compatible shipping casks as dual-purpose casks.

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A.W. Brant, WasteChem Limited, Bramhall, United Kingdom

**Decommissioning of Fuel Pie Caves at Berkeley Nuclear Laboratories**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 175-179) (April 1990)

This paper describes the first major contract awarded to private industry to carry out decommissioning of a facility with significant radiation levels. The work required operatives to work in pressurized suits, and entry times were significantly affected by sources of radiation in the Caves, initially being as low as 30 minutes per day. Post irradiation examination of fuel element support units and reactor core components from Central Electricity Generating Board power stations are carried out in the Caves at Berkeley Nuclear Laboratories. This decommissioning work is part of an overall refurbishment of the facility to allow the receipt of Advanced Gas-cooled Reactor Fuel Stringer Components direct from power stations. The paper also describes the decommissioning and decontamination of the facility from the remote removal and cleanup work carried out by the client to the hands-on work. It includes reference to entry times, work patterns, interfaces with the client, and the operations of the laboratory. Details of a specially adapted size reduction method are given.

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British Nuclear Energy Society, London, United Kingdom

**Radioactive Waste Management 2 - Vols. 1 and 2: Contents**

CONF-890544; Proceedings of an International Conference, Brighton, United Kingdom, May 2-5, 1989, Vols. 1 and 2, 356 pp.; (10 pp.) (1989)

These pages give the contents of the two volumes of proceedings of the above-listed conference on radioactive waste management. A total of 69 conference papers and posters are listed by title along with the author and corporate affiliation of each. General topics include Public Interest, Waste Treatment, Storage and Disposal, Assessment and Modeling, and Policy and Strategy, along with a Corrigendum.

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S. Buck, J.P. Ronaldson, and A.P. Colquhoun, British Nuclear Fuels Limited, Sellafield, Seascale, Cumbria, United Kingdom

**Plutonium Inventory Measurements During Decommissioning Operations**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 797-806) (1990)

The Sellafield plant of British Nuclear Fuels Limited (BNFL) has handled radioactive materials for over 40 years and plutonium since the early 1950s. As part of the overall decommissioning program for the site, BNFL has recently undertaken the dismantling of a mixed-oxide fuel manufacturing plant which has yielded valuable information in terms of project management, manpower requirements, and radiation uptake. The project was deliberately chosen as a test bed for the development of decommissioning equipment and, particularly, methods of locating and measuring plutonium residues before and during dismantling using in situ assay techniques. Prototype equipment has now been used over a two year period for items ranging from glove boxes of 10 sq m volume down to geometrically safe storage tanks made from 100 mm pipe and has proven invaluable. This review of experience highlights opportunities for improvements in the equipment and additionally considers means of applying in situ plutonium assay in locations having access constraints or more complex chemical or plutonium isotopic compositions than was the case in this initial application.

122

T. Candelieri, A. Gerardi, and G. Soffietto, European Nuclear Energy Agency, Dipartimeinto Ciclo del Combustibile, Trisaia, Italy

**Rack Removal System as a New Design Feature Adopted to Facilitate Decommissioning of Reprocessing Plants: Decontamination and Remote Dismantling Tests in the ITREC Pilot Plant**

ETDE-IT-90-89; CONF-891077; Decommissioning of Nuclear Installations, Proceedings of the 1989 International Conference, Brussels, Belgium, October 24-27, 1989. Commission of the European Community, Brussels, Belgium; (15 pp.) (October 1989)

The scope of this research was to evaluate the advantages of a rack removal system for dismantling reprocessing installations (i.e., to verify experimentally the possibility of decontaminating any particular module and the capability for remote dismantling of components installed in the mobile rack). In particular, the main objective was to develop remotely operated equipment for the dismantling of centrifugal contractors. Decontamination of the equipment, which represents the most important preliminary phase of the decommissioning operation, allowed the achievement of low levels of radioactivity. A supporting program was performed to define data for the design of the remote dismantling machine. On the basis of technological cold test results, the dismantling machine's construction was optimized. Positive results obtained during the hot dismantling operations attested to the effectiveness of the rack removal system as an original design that provides easier decommissioning of reprocessing plants.

123

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

**Applying Construction Lessons to Decommissioning Cost Estimates**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 8; (pp. 105-117) (1991)

One of the standard practices in estimating costs for new procedures is to apply past experience. In this chapter the author uses prudency hearings and other data from power plant construction to illuminate some of the pitfalls likely to be encountered in preparing estimates for power plant decommissioning. Two of the most tempting pitfalls are scale and learning economies. These presumed economics have had less impact than expected on keeping construction costs down, and they also are unlikely to have much effect on decommissioning costs. Ignoring this evidence could result in decommissioning cost estimates that are too low and collection strategies that are inadequate. This finding has implications for future generations and future decommissioning plans.

124

H. Carlsen, Risoe National Laboratory, Department of Materials, Roskilde, Denmark

**Decommissioning of the Risoe Hot Cell Facility - Periodic Report Covering July 1 to December 31, 1990**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (9 pp.) (August 1991)

The hot cell facility at Risoe has been in active use since 1964. During those years several types of nuclear fuels have been handled and examined at Risoe, including (1) test reactor fuel pins from the Danish reactor DR3, the Norwegian Halden reactor, etc.; (2) power reactor fuel pins from several foreign reactors, including plutonium-enriched pins; and (3) high-temperature gas-cooled reactor fuel from the Dragon reactor. All kinds of physical and chemical nondestructive and destructive post irradiation examinations have been performed. Also, different radiotherapy sources have been produced, mainly cobalt sources. Because nuclear power was excluded from Danish national energy plans several years ago, the interest in Risoe hot cell work has decreased. Thus the decision has been made to decommission the hot cell facility. The general object of the decommissioning program is to obtain a safe condition for the total building that does not require the special safety precautions that were necessary for the operation of the building as a hot cell plant. As a result the building will be usable for other purposes after the decommissioning is completed. The facility comprises six concrete cells, lead cells, glove boxes, a shielded unit for temporary waste storage, a frogman area, decontamination areas, workshops, various installations of importance for safe operation of the plant, offices, etc. The various decommissioning tasks include removal of all irradiated fuel items, removal of other radioactive items, removal of contaminated equipment, and decontamination of all the cells and rooms. The project goal is to decontaminate all concrete cells to a degree where no loose contamination exists, a level at which total removal of the cell structures could be accomplished without significant dose commitments.

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R.W. Carlson (ed.), Lawrence Livermore National Laboratory, Livermore, CA

**Regulatory Philosophy and Intent of Radioactive Material Transport Including Transport of Components from Decommissioned Nuclear Facilities**

Proceedings of the 1990 Pressure Vessels and Piping Conference, Nashville, TN, June 17-21, 1990. American Society of Mechanical Engineers, New York, NY, 51 pp. (1990)

This conference proceedings contains 8 papers. The topics discussed are (1) deflection, post-buckling behavior, and inelastic energy dissipation in cylindrical shipping containers dropped on one edge; (2) truck shipping-cask development for the U.S. Department of Energy Office of Civilian Radioactive Waste Management cask systems development program; (3) thermal testing of solid neutron shielding materials; (4) collapse analysis of toroidal shell; (5) problems during certification of radioactive material packages; (6) Three Mile Island Unit 2 reactor vessel and balance-of-plant status; (7) certifying the decommissioned Shippingport Reactor vessel for transport; and (8) the decision process involved in preparing the Shippingport Reactor pressure vessel for transport.

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D. Chapman, Cornell University, Department of Agricultural Economics, Ithaca, NY

**Decommissioning and Waste Policy: Comprehensive or Separable?**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 19; (pp. 247-254) (1991)

Waste handling is one of the tasks most likely to drive up decommissioning costs. This expense is derived from the large volumes of waste involved, from public apprehensions about its safe and prudent disposal, and from the uncertainties associated with long-term on-site storage of waste as is the current practice. Current U.S. nuclear policy addresses low-level waste (LLW) separately from civilian waste, and even has different packaging requirements for different types of LLW. These differences mean that there are different disposal sites, different transportation routes, and reduced economies of scale. The author argues for a more comprehensive disposition of this waste and a reexamination of national waste policy.

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R. Chowdhury, Bhabha Atomic Research Centre, Reactor Group, Bombay, India

**Planning, Preparedness and R&D Activities on Decommissioning of Research Reactors and Other Small Nuclear Facilities in India**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (7 pp.) (August 1991)

This paper covers some of the Indian experiences in the field of nuclear facility decommissioning, and also covers planning and developmental work being done in anticipation of the decommissioning of the CIRUS reactor. India has considerable experience in reactor decommissioning and other related activities. ZERLINA (Zero Energy Reactor for Lattice Investigations and New Assemblies) was decommissioned in 1983 after serving its useful life of 22 years. A number of repair/rehabilitation jobs in high radiation environments and areas with difficult access have been carried out in various units, including the power plants. APSARA, India's first research reactor, has been in service for 35 years and is operating satisfactorily. Future decommissioning of this reactor can be accomplished without much difficulty in light of the international experience available. Because of the complexity of its systems, the decommissioning of CIRUS will require a substantial amount of preparatory work, research and development. Before the decommissioning job is begun, required development work and trial runs for critical operations will be performed.

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G. Clement and G. Coste, Commissariat a l'Energie Atomique, Fontenay aux Roses, France

**CEA's RD 500 has the Power for Decommissioning**

Nuclear Engineering International 34(424):49-51 (1989)

Having found that existing equipment could not cope with the scope of its dismantling program, the French Commissariat a l'Energie Atomique has developed a new manipulator with a 500N payload capacity (RD 500). The first use of the RD 500 is scheduled to be for dismantling the ATI prototype reprocessing plant where it will be used with the ATENA transporter to dismantle all the process piping in blind concrete cells. If enough experience is gained, the RD 500 will then be used in similar tasks, and also in underwater work, in a pool-type reactor dismantling project which is due to start shortly.

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L.W. Cole, S.V. Prewett, and A. Bonifacio, Aerojet Ordnance Tennessee, Inc., Jonesboro, TN; Chem-Nuclear Systems, Inc., Columbia, SC

**Challenges in Decontamination of a Depleted Uranium Manufacturing Facility**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 567-570) (March 1989)

Aerojet Ordnance Tennessee (AOT) had responsibility to decommission a manufacturing facility in Compton, California, used to manufacture depleted uranium penetrators. The facility had been in operation for 10 years and had manufactured more than 18 million penetrators for the Air Force GAU-8 Weapons Systems. AOT was assisted by Rogers and Associates of Salt Lake City in the technical aspects of both the planning phase and the operational phase of the project. Chem-Nuclear Systems of Columbia, South Carolina, was the prime contractor for the decontamination effort. The project required more than 40 work-hours of effort and cost nearly $4 million. This paper focuses on the challenges of dealing with regulatory agencies, decision making, confirmatory surveys, management oversight, final review, and required reporting which arose from the decommissioning project.

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Commissariat a l'Energie Atomique, Unite de Demantlement des Installations Nucleaires, Marcoule, France

**French Decommissioning Policy for Nuclear Facilities**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria (June 1991)

This handout given at the Research Coordination Meeting is a visual presentation of French nuclear decommissioning policy. The presentation includes one-page outlines of these aspects of French decommissioning policy: (1) regulatory aspects, (2) technical and economic aspects, (3) adopted strategies according to categories of nuclear facilities, (4) financial provisions for decommissioning, (5) radioactive waste management, (6) research and development activities objectives, and (7) research and development activities topics. Also included are a Commission de l'Energie Atomique (CEA) organization chart, CEA 10-year dismantling plan, and a map of dismantling operations in progress.

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Commission of the European Communities, Directorate-General for Science, Research and Development Joint Research Center, Brussels, Belgium

**EC Programme on Decommissioning of Nuclear Installations**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (5 pp.) (June 1991)

To promote a safe and orderly dismantling of obsolete facilities, the European Community has since 1979 been carrying out five-year research and development (R&D) programs on decommissioning of nuclear installations. The current program, the third of its kind, will conclude at the end of 1993. The funds estimated to be necessary for the execution of the program amount to 31.5 million ECU, including staff expenditures. The Community funds up to 50% of the cost of a research project on shared-cost contracts with research organizations and firms in the member states. This report lists and summarizes the activities under the three main categories of R&D pursued under the present five-year program: (1) research and development projects, (2) identification of guiding principles, and (3) testing of new techniques in practice.

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**SMANT: A Computer Program to Determine**

**the Minimum Occupational Doses Pathways in Dismantling Operations**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 434-436) (1988)

In the near future, some nuclear installations could be decommissioned in Italy. For that reason, the European Nuclear Energy Agency (ENEA) Italian Committee on Nuclear Energy and Alternative Sources is carrying out research and development activities for improving technologies to achieve the best dismantling conditions for workers, especially in terms of radiation doses. This framework called for a computer program that could quickly evaluate the best way to remove contaminated components from a plant using the appropriate and available technologies. Such a computer program, named SMANT, has been developed at ENEA. It is the first example of a computerized method intended to support the project staff in evaluating dismantling scenarios in Italian nuclear installations. The SMANT program is described in this paper.

**133**

J.R. Costes, C. de Tassigny, and H. Vidal, Commissariat a l'Energie Atomique, Etablissement de la Vallee du Rhone, Bagnols-sur-Ceze, France

**Conditioning of Graphite Bricks from Dismantled Gas-Cooled Reactors for Disposal**

Waste Management 10(4):297-302 (1990)

Dismantling of gas-cooled reactors to decommissioning stage 3 will involve tens of thousands of low-level radioactive graphite bricks. These bricks will contain less than 400 GBq of tritium per metric ton, less than 20 GBq/Mg X 10(E-1) of C-14 and less than 2 GBq/Mg X 10(E-1) of Cl-36. The long half-life of the last two nuclides may require long-term conditioning. Core impregnation is one way to minimize leaching under these conditions. The authors show (1) that core impregnation is possible using extremely durable pitches or bitumens; (2) that inspection is possible by porosity monitoring and x-ray examination; and (3) that satisfactory leach test results have been obtained on actual graphite samples from a reactor operated for 20 years. The very simple technology required for industrial implementation is discussed.

**134**

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**Conditioning for Definitive Storage of Radioactive Graphite Bricks from Reactor Decommissioning**

EUR-12815; 86 pp. (1990)

The decommissioning of gas-graphite reactors in the European Community (e.g., French UNGGs, British Magnox reactors and AGRs, and reactors in Spain and in Italy) will produce large amounts of graphite bricks. This graphite cannot be accepted without particular conditioning by the existing shallow land disposal sites. The aim of the study is to examine the behaviour of graphite waste and to develop a conditioning technique that makes this waste acceptable for shallow land disposal sites. Eighteen kg of graphite core samples with an outside diameter of 74 mm were removed from the G2 gas-cooled reactor at Marcoule. Their radioactivity is highly dependent on the position of the graphite bricks inside the reactor. Measured results indicate an activity range of 100-400 MBq/kg with 90% tritium, 5% C-14, 3% Co-60, 1.5% Ni-63. Repeated porosity analyses showed that open porosity ranging from 0 to 100 microns exceeded 23% volume in the graphite. Water penetration kinetics were investigated in unimpregnated graphite and resulted in impregnation by water of 50-90% of the open porosity. Preliminary lixiviation tests on the crude samples showed quick lixidegree of cesium (several percent) and Co-60, and, to a lesser degree, of Ba-133. The proposed conditioning technique involves true impregnation by a tar-epoxy mixture rather than a simple coating. The bricks recovered intact from the core by robot services will be placed one by one inside a cylindrical metallic container. This container may corrode and the bricks may become fragmented in the future, but the normally porous graphite will be unaffected by leaching because, as has been proven, all pores larger than 0.1 microns will be filled with the tar-epoxy mixture. This is a true long-term waste packaging concept. The very simple technology required for industrial implementation is discussed.

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**Advanced Semi-Autonomous Robotic System for Hazardous Response Work for Decontamination and Decommissioning**

Remote Systems Technology, Proceedings of the 38th Conference, Washington, DC, November 1990. American Nuclear Society, La Grange Park, IL, Vol. 2; (pp. 79-85) (1990)

The Articulated Transporter/Manipulation System is being developed by the University of Florida and Odetics as part of a University Program in Robotics for Advanced Nuclear Reactors. It is felt that the articulated body concept offers particular advantage in maneuvering through the cluttered areas of nuclear power plants. Extensive work has been completed by Odetics in developing electric motors to provide the required torque, while meeting size, power, and heat-removal constraints. The University of Florida has developed control algorithms that effectively let the operator locate start points and end points via a mouse, specify maximum torque loads, and then preview the operation prior to actual implementation.

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**Project Management and General Planning for the Garigliano BWR and the Latina GCR: Situation as of May 1991**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (5 pp.) (June 1991)

This paper is a follow-up to a previous paper on the same subject, presented in October, 1989. Since that time the situation in Italy has changed somewhat, with the decision made by the Italian government on July 27, 1990, concerning the final shutdown of the Trino and Caorso nuclear power plants. The plants must be put in a condition of "Passive Safe Enclosure" [Custodia Protettiva Passiva (CPP) in Italian]. This corresponds to a condition intermediate to Stages 1 and 2 on the International Atomic Energy Agency scale. The subject of decommissioning in Italy is now seen within an expanded framework, namely the decommissioning of all four Italian nuclear power plants. For the Garigliano reactor, CPP is foreseen for the end of 1996. This paper lists all activities completed or programmed for the attainment of CPP conditions at Garigliano. For the Latina reactor, which is now being defueled, CPP will be achieved in the year 2000, with total dismantling and unconditional release of the site some decades after. Decommissioning activities there are in the planning stage. With the Italian government's decision on the final shutdown of the Trino and Caorso reactors, the strategy is to reach CPP in 10-12 years, and to defer dismantling for some decades. Defueling activities at these two reactors will begin in early 1992.

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**Reactor Decontamination: A Literature Review with Recommendations for Decontamination of the N.S. Savannah Reactor**

BAW-1217; 68 pp. (December 1960)

Chemical decontamination methods of the primary cooling systems of water-cooled reactors and reviews the literature concerning these methods are discussed. Specific recommendations for the best decontaminant solution for maintenance of the N.S. Savannah Reactor are made.

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M.V. Davis, EG&G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, ID

**Decontamination of Lead by Refining Bench-Scale Testing**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 653-657) (March 1989)

This report describes a bench-scale refining test to remove radioactive contamination from lead. The equipment used, the procedures employed, and the results obtained from tests performed at Idaho National Engineering Laboratory are described. Lead is a hazardous material. When it becomes radioactively contaminated and can no longer be used, it is a mixed waste. These regulations require hazardous waste to be treated prior to disposal. Presently, there is no treatment process that will render lead nonhazardous, nor is there a disposal site that will accept lead as a mixed waste. Decontamination is the only alternative. Several melts were prepared using clean lead to which known quantities of Co-60, Sr-85, and Cs-137 were added. Flux materials were then added to the molten lead to fuse the isotopes in the dross, which would migrate to the surface and be removed. Samples of the molten lead, dross, and the resulting lead ingots were analyzed to determine the success of isotope removal. Smears were also taken from tools, equipment, and the test area to assess the spread of contamination, if any.

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**Dumping of Decommissioned Nuclear Submarines at Sea: A Technical and Legal Analysis**

Marine Policy 14(6):467-476 (1990)

Approximately 300 nuclear-powered submarines will become obsolete by the turn of the century, and some nations have considered sea dumping as a disposal option. Decommissioned nuclear submarines contain substantial radioactivity, however, and hence a policy of sea dumping would imply resumption of radioactive waste dumping at sea in contravention of the present global moratorium on this practice. The International Atomic Energy Agency charter to promote atomic energy may create a conflict of interest with its regulatory role in sea dumping. It is concluded that disposal of nuclear submarines at sea corresponds to dumping, and that decommissioned nuclear submarines lack sovereign immunity. Therefore, sea dumping of nuclear submarines is subject to regulation by international conventions.

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**Examination and Long-Term Assessment of Nuclear Power Plant Structures**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 136-140) (April 1990)

This report is concerned with the concrete structures that enclose the reactors of nuclear power plants. These structures are of two types: reinforced concrete biological shields that surround the early Magnox reactors housed in steel pressure vessels and prestressed concrete pressure vessels that fulfill the dual role of biological shield and pressure vessel for the later Magnox and the Advanced Gas-Cooled Reactors. Substantial experience (over 30-years) has been accumulated in the design, surveillance, and assessment of these structures. This experience is now being directed towards providing assurances of their ongoing serviceability during their operational life and their continued functioning during the decommissioning stages. This paper summarizes the experience gained by the examination of nuclear structures and the methods that have been developed to predict the future performance of nuclear reactors.

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**New Emphasis of IAEA's Programme on Decommissioning**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; CONF-910270; Waste Management '91: Working Towards a Cleaner Environment - High-Level Waste, Low-Level Waste, Mixed Waste and Environmental Restoration, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 24-28, 1991; (6 pp.) (June 1991)

Decontamination and decommissioning (D&D) activities were introduced in the International Atomic Energy Agency's (IAEA's) program in 1973. At present, all D&D activities of IAEA are consolidated with the solid waste program. Since 1980, IAEA has published 11 technological review reports and four safety and regulatory guidance reports in the area of D&D. IAEA has also launched Coordinated Research Projects (CRPs), like the ones described in handouts at this meeting, on decontamination and environmental restoration to be carried out in cooperation with the Chernobyl Center for International Research. A total of 32 handouts given out during the CRP meeting are included with this programmatic introduction by the meeting's scientific secretary. It is recognized that the existing IAEA technical publications generally satisfy the current needs of member states. As decommissioning activities become more frequent, emphasis of the agency's D&D program has been shifted to other areas of interest that cover regulations, standards, guides and direct assistance to member states. A highlight of the program is the preparation of the publication "Safety Standards on Decommissioning," to be accompanied by two safety guides. In response to specific needs of developing member states, work has been initiated on the preparation of reports on planning and management aspects (including the economic evaluation) of decommissioning research reactors and other small nuclear facilities such as radiochemical laboratories, hot cells, etc. Transfer of experience and know-how will be provided via an interregional training course on decontamination of research reactors, scheduled to be held in France this year. Increased emphasis will also be placed on technical assistance and expert services to developing countries on the safe confinement, rehabilitation, and long-term storage of mill tailings, and on environmental restoration of mining and milling sites.

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P.L. De, International Atomic Energy Agency, Division of Nuclear Fuel Cycle and Waste Management, Vienna, Austria

**Cost of Decommissioning Nuclear Power Plants**

IAEA Bulletin 32(3):39-42 (1990)

Over the past 35 years, considerable experience has been gained in decommissioning many types of nuclear facilities. By the turn of the century, more than 60 nuclear power plants and 250 research reactors around the world will become likely candidates for decommissioning. Several factors influence the choice of decommissioning strategy in a country and consequently, the decommissioning cost estimates performed are difficult to compare. International efforts to harmonize the various estimates are essential. The International Atomic Energy Agency introduced the concept of various cost elements or components, a suggested methodology, and it has also undertaken, in its 1991-92 program, some specific studies on a common methodology for decommissioning cost estimation.

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P.L. De, International Atomic Energy Agency, Division of Nuclear Fuel Cycle and Waste Management, Vienna, Austria

**Decontamination and Decommissioning of Nuclear Facilities: Final Report of Three Research Co-ordination Meetings Organized by the International Atomic Energy Agency and Held Between 1984 and 1987**

IAEA-TECDOC-511; Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (104 pp.) (June 1991)

The first International Atomic Energy Agency (IAEA) Coordinated Research Program (CRP) on decontamination and decommissioning was initiated in 1984. Nineteen experts from 11 member states and two international organizations [Commission of the European Communities and the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA)] took part in the three research coordination meetings (RCMs) during the 1984-87 program period. The final RCM at that time took place in Pittsburgh, Pennsylvania, in conjunction with the 1987 International Decommissioning Symposium, sponsored by the U.S. Department of Energy and organized in cooperation with the IAEA and OECD/NEA. The present document summarizes the salient features and achievements of the CRP performed during that program period. The objectives of the CRP during 1984-87 were to (1) promote the exchange of information gained by different countries in decontamination and decommissioning, (2) stimulate cross- and inter-disciplinary research on all aspects of these topics, and (3) give the participants in the CRP an opportunity to visit sites where decommissioning activities were in progress.

144
T. Dibdin

**Decommissioning: The Final Folly**

SCRAM (Scottish Campaign to Resist the Atomic Menace) Anti-Nuclear and Safe Energy Journal 77:12-13 (June-July 1990)

The Second International Seminar on Decommissioning of Nuclear Facilities held in London is reviewed. Various solutions to reactor decommissioning, including isolating the reactor core and turning the surrounding buildings into a theme park, are mentioned. The International Atomic Energy Agency identifies three decommissioning stages: (1) defueling; (2) dismounting of the nonradioactive plant and isolating the nuclear island; and (3) returning to a "greenfield" site. The real debate is about waste management and timing of the stages - whether to defer stage 3 for a century or so, or even whether to attempt stage 3 at all. Cost estimation is also discussed. In the United Kingdom, the date of completion of the deep repository for high-level waste will affect the timing of decommissioning.

145
W.J. Dodson, H.H. Isakari, J.F. Munro, T.H. Lim, M.M. Denton, and P.G. Vernig, California University, Department of Nuclear Engineering, Berkeley, CA

**Planning for the Decommissioning of a Research Reactor**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 346-348) (1988)

This paper describes the steps that must be taken and the uncertainties and potential pitfalls that can be encountered in decommissioning a research reactor, whether owned by private industry, a university, or a government agency. The paper is based on experience in preparing the TRIGA Mark III Berkeley Research Reactor for decommissioning. Six topics of interest to an owner-operator are addressed: (1) task and schedule planning, (2) decommissioning organization, (3) cost estimating, (4) health and safety considerations, (5) waste management, and (6) regulatory concerns.

146
P. Drews and K. Fuchs, Commission of the European Communities, Luxembourg

### Development of Measuring and Control Systems for Underwater Cutting of Radioactive Components

EUR-12869; 66 pp. (1990)

Shutdown and dismantling of nuclear power plants require special techniques to decommission the radioactive components involved. For safety reasons, decommissioning of components underwater can be advantageous because of the radioactive shielding effect of water. In this project, research and development activities focused on different sensor systems and their adaptation to cutting tasks. A new image-processing system has been developed in addition to the modified underwater TV camera used for optical cutting-process control (plasma and abrasive wheel cutting). For control of process parameters, different inductive, ultrasonic, and optical sensors have been modified and tested. The investigations performed are aimed at assuring high-quality underwater cutting with the help of sensor systems specially adapted to cutting tasks and with special signal procession and evaluation through microcomputer control. It is important that special attention be paid to the reduction of interferences in image pick-up and procession. The measuring system has been developed to meet the demands of underwater cutting processes. The reliability of the system has been tested in conjunction with a four-axes handling system.

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W.D. Drotning and P.C. Bennett, Sandia National Laboratories, Albuquerque, NM

### Intelligent Systems for Remote Decommissioning in Hazardous Environments

SAND-90-3065C; CONF-910602; Proceedings of the 1991 American Society of Mechanical Engineers Pressure Vessels and Piping Conference, San Diego, CA, June 23-27, 1991; (13 pp.) (1991)

Investigation of advanced technologies utilizing intelligent machines is being supported jointly by the U.S. Department of Energy Offices of Civilian Radioactive Waste Management and Environmental Restoration and Waste Management for automation of transportation package-handling operations at nuclear facilities and of nuclear waste site remediation efforts. Handling operation requirements include identification, location, and health physics operations, followed by bolting/unbolting operations and package disassembly. To accommodate these operations and the diversity of packages, fast, model-based automated programming and force feedback control of a robotic cask-handling system were developed. In addition, sensor-directed model-based robotic control has been demonstrated for application to hazardous material cleanup. In this application, a graphic interface is used to simulate and evaluate operator-controlled motions and to provide telerobotic control of the system. The remote automated handling technologies developed through these programs have the potential to decrease worker exposure and to increase efficiency during decommissioning activities in hazardous environments.

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S.M. DuBoff and D.F. Stenger, Winston & Strawn, Washington, DC

### Divided Authority: Federal vs. State Policy Roles in Decommissioning Economics

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 6; (pp. 73-84) (1991)

This chapter looks at federal and state roles in regulating nuclear power plant decommissioning from the legal perspective by comparing the radiological obligations and responsibilities which dominate at the federal level and the economic obligations and responsibilities which dominate at the state level. The chapter examines how the Nuclear Regulatory Commission addressed the state role in its new rule on decommissioning, and looks at the applicable regulatory provisions of several states. It is concluded that the present dual system of regulation presents a potential for conflict on decommissioning economics, particularly with regard to the adequacy of fund accumulation.

**149**
M. Dubourg, Fromatom Tour Fiat, Paris, France

**Design Improvement to Facilitate Decommissioning of PWRs**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 132-135) (April 1990)

Experience gained over the past 25 years in the design and construction of light-water reactors combined with expertise gained by personnel involved in the design of the first nuclear power plants have contributed to the development of skills, equipment, and capabilities necessary for nuclear facility dismantling and shutdown. Elements with small amounts of tracing materials such as niobium and cobalt are of prime importance for the design of structures submitted to neutron fluxes or structures in close contact with the primary coolant (i.e., steam generator tube bundle). Additional efforts must be devoted to improving the cost of dismantling operations and minimizing the volume of radioactive waste arising from decommissioning. Of major importance to the nuclear industry are waste volume reduction technologies such as incineration, calcination, and encapsulation combined with the retrieval of materials and the recycling of contaminated components for possible reuse. In fact, the retrieval of highly valuable materials and the recycling of contaminated equipment using appropriate decontamination and segmentation techniques could solve the problems associated with radioactive waste storage.

**150**
M. Dubourg, Societe Franco-Americaine de Constructions Atomiques (Framatom), Paris-la-Defense, France

**Improved Decommissioning Methods**

Framatome Newsletter 38:14-18 (November 1990)

Analyzing the design of both 900 MW(e), 1300 MW(e), and future 1450 MW(e) class French pressurized water reactor units reveals that design improvements made to reduce occupational dose exposure of maintenance personnel, along with the development of automated tools for performing maintenance and repairs of major components, will help to make future dismantling and decommissioning operations easier.

**151**
**Early Decommissioning and Repowering for Fort St. Vrain**

Nuclear Engineering International 35(434):37 (September 1990)

The Public Service Company of Colorado has begun negotiations with three companies for the early decommissioning and repowering of its Fort St. Vrain high temperature gas-cooled reactor as a gas-fired facility; however, the defueling process was suspended due to lack of on-site fuel storage, and the company may face delays in completing the decommissioning and conversion.

**152**
EG&G Idaho, Inc., Idaho Falls, ID

**U.S. Department of Energy Three Mile Island Research and Development Program 1989 Annual Report**

DOE/ID-10289; 39 pp. (July 1990)

Defueling of the Three Mile Island Unit 2 (TMI-2) reactor continued through 1989. This report summarizes that work and other TMI-2-related cleanup, research, and development activities. The major topics in this report include (1) waste immobilization; (2) core debris transportation, receipt, and storage; (3) accident evaluation program; and (4) the technical integration program. Significant progress was made toward completing the U.S. Department of Energy programmatic effort to support cleanup of the

TMI-2 facility. Completion of this effort is expected during 1990.

153
M. Enda and R. Reiko, Toshiba Corporation, Tokyo, Japan

**Decontamination Apparatus for Metals**

K/TR 91/3; Japanese Kokai Patent HEI 2[1990]-27298; 28 pp. (1990)

The patent is for a metal decontamination apparatus using a decontamination solution containing trivalent cerium ion [Ce(E3+)] and tetravalent cerium ion [Ce(E4+)] to produce Ce(E4+) from Ce(E3+) by electrochemical redox reaction. The oxidation power is then used to convert Ce(E4+) and Ce(E3+) for dissolution and removal of the surface of the contaminated metal. An ionic electrode apparatus, selectively sensitive to Ce(E3+) and Ce(E4+) in the decontamination solution, and a potentiometer are incorporated in the area in contact with the decontamination solution. The apparatus is for decontamination of radioactive waste material from nuclear power facilities.

154
C. Feldman, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

**Standard Format and Content for Decommissioning Plans for Nuclear Reactors**

REG/G-90001148; 23 pp. (September 1989)

General requirements for applications for license termination and decommissioning of nuclear reactors are contained in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," in section 50.82, "Applications for Termination of Licenses." On June 27, 1988 (53 FR 24018, to be effective July 27, 1988), the Nuclear Regulatory Commission (NRC) published amendments to 10 CFR Part 50, along with other parts of its regulations, concerning specific criteria for decommissioning nuclear facilities. The revised section 50.82 requires that an application for license termination be accompanied or preceded by a proposed decommissioning plan. This draft regulatory guide has been developed and issued for public comment in conjunction with publication of the decommissioning rule. The purpose of this guide is to identify the information needed and to present a format acceptable to the NRC staff for preparing and submitting a decommissioning plan.

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M.A. Feraday, M.A. Feraday and Associates, Etobicoke, Ontario, Canada

**Recovery Operations in the Event of a Nuclear Accident or Radiological Emergency**

IAEA-SM-316/12; Recovery Operations in the Event of a Nuclear Accident or Radiological Emergency, Proceedings of an International Symposium, Vienna, Austria, November 6-10, 1989. International Atomic Energy Agency, Vienna, Austria, 657 pp.; (pp. 283-300) (1990)

In spite of all precautions, the possibility of an accident at a nuclear power plant that would cause the release of unacceptable amounts of radioactive material and serious contamination of surrounding areas cannot be excluded. One protective measure that may be required during the intermediate and late phases of an accident is the cleanup of contaminated areas. The term "cleanup" includes decontamination, stabilization or isolation of the contamination, and the transport and disposal of wastes arising from cleanup. If the emergency director decides to implement cleanup after a serious accident, all reasonable means should be used to minimize the huge costs and the risks to human health. Ensuring that the cleanup can be quickly and efficiently carried out requires good preliminary planning, clear strategies, a good managerial team, well trained workers, and suitable equipment. To assist member states in developing their emergency preparedness plans for cleanup, the International Atomic Energy Agency (IAEA) is preparing publications that provide an integrated overview of the operational planning for cleanup, the methods and equipment to carry out remedial actions, and the means to transport safely and dispose of the large volumes of waste. This paper provides an overview of the information in the IAEA reports.

**156**

M.J. Fisher, Public Service Company of Colorado, Boulder, CO

**Status of the Fort St. Vrain Decommissioning**

Excellent and Economic Nuclear Plant Performance, S.R. Penfield Jr. (ed.), Proceedings of the Combined ANS Power Division Topical Meeting and ASME Nuclear Energy Conference, Newport, RI, September 16-19, 1990. American Society of Mechanical Engineers, New York, NY, Vol. 4; (p. 91) (1990)

Fort St. Vrain (FSV) is a high-temperature, gas-cooled reactor. It has been shut down as a result of financial and technical difficulties. Public Service Company of Colorado (PSC) has been planning for FSV defueling and decommissioning for at least three years. The preliminary decommissioning plan, in accordance with the Nuclear Regulatory Commission's (NRC's) final rule, has been submitted and is being reviewed by the NRC. The basis of the preliminary decommissioning plan has been SAFSTOR, the nondecontaminated storage of the facility. PSC, who is the owner and operator of FSV, is scheduled to submit a proposed decommissioning plan to the NRC some time in the fourth quarter of 1990. PSC has gone out for bid on the decontaminating and dismantling of FSV. These bids are being evaluated and will be utilized to make the decision on the decommissioning final alternative that will be chosen for the decommissioning of FSV. The decision on the decommissioning alternative (SAFSTOR or DECON, the hard decontamination option, as delineated in the NRC rule) will be the basis for the proposed decommissioning plan. PSC is also pursuing, with the NRC, the issuance of a possession-only amendment to the 10 CFR 50 license currently possessed by FSV. The decommissioning and defueling project status will be the main focus of the presentation to the joint American Society of Mechanical Engineers/American Nuclear Society meeting in September 1990. The presentation will include (1) the defueling schedule; (2) the independent spent-fuel storage installation status; (3) the probability of shipping fuel to DOE; (4) the status of the preliminary decommissioning plan submittal; (5) the issuance of a possession-only license (and the results of obtaining this license amendment); (6) preliminary decommissioning activities allowed prior to the approval of a proposed decommissioning plan; and (7) the preparation of a proposed decommissioning plan, depending on the status of the decision to proceed with SAFSTOR or DECON as identified in the NRC's final decommissioning rule. The presentation will be updated to reflect FSV's decommissioning status in the September time frame. This should provide the joint ASME/ANS meeting with the most up-to-date information available concerning FSV.

**157**

C.C. Fleischer, Taylor Woodrow Construction Limited, Southall, United Kingdom

**Controlled Use of Explosive Techniques in the Decommissioning of Nuclear Facilities**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 58-67) (April 1990)

The decommissioning of nuclear facilities calls for the controlled removal of activated and/or contaminated materials from the insides of biological shielding structures while relying on the outer layers of nonactivated or contaminated material to contain the activity. This report describes the development work being performed on the controlled use of explosives to cut and remove selected parts of biological shielding structures without impairing the overall containment integrity. The technique being developed is also applicable to other controlled cutting of concrete requirements outside the nuclear industry. This report reviews work done to optimize the concrete cratering effectiveness of the explosive charges and reports on investigations done on concrete removal from re-entrant corners, on curved surfaces, and from behind reinforcement and steel liners. Procedures for achieving a required level of material removal without impairing the remaining structure are delineated. The use of explosives for the creation of charge holes is discussed, along with reports on tests used to assess the particle size distribution in the dust generated during blasting.

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R.H. Flowers and J. Williams, United Kingdom Atomic Energy Authority, Fuel Processing Directorate, Harwell, United Kingdom

**Strategy and Planning for Decommissioning of UKAEA Facilities**

CONF-900387; Decommissioning of Nuclear Facilities, Proceedings of the Second International Seminar, London, United Kingdom, March 19-20, 1990, 405 pp.; (pp. 6-8) (July-August 1990)

There are many important factors to consider when defining the priority of a decommissioning task. These include safety, the cost of dismantling versus maintenance, waste management costs, reuse of the facility, dependence on other facilities, licensing, and the availability of experienced staff. In this paper, the evaluation process used to categorize the phasing of the decommissioning of United Kingdom Atomic Energy Authority facilities is described.

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S. Fothergill and G. MacKerron, Cambridge University, Cambridge, United Kingdom; University of Sussex, Science Policy Research Unit, United Kingdom

**The Economics and Financing of Decommissioning**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 3; (pp. 41-58) (1990)

Economics and financing hold the most immediate interest for the public. Largely this interest stems from the effect of decommissioning on current utility rates, but there are other related issues as well. These include the question of whether adequate funds will be available when needed, how they will be collected and invested, and what constitutes reasonable contingency factors and discount rates. Preliminary examination of the economics of decommissioning raises more questions than it answers. Each country or area of a country (as in the United States) will be faced with establishing its own policies. Whichever methods and logic are finally applied to the economics of decommissioning in the United Kingdom, the public will eventually pay. For this reason, a clear working knowledge of the principal elements of this consideration is important.

160

V.A.E. Fountain, Institution of Electrical Engineers, London, United Kingdom

**Decommissioning Soviet Nuclear Plants**

IEE Reviews 36(3):102 (March 8, 1990)

The Chernobyl accident produced a change in approach to nuclear plant decommissioning in the USSR. It was realized that insufficient preparation had been made, so a national scientific and technological plan for 1988-1995 was set up to investigate the lay-up and burial of the nuclear plant equipment and building structures after the standard term of operation of nuclear power plants. The Soviet approach to decommissioning is to remove radioactive material from nuclear sites and dump it permanently in underground vaults. The time betw-- shutdown and dismantling may be considerable, and in the meantime the plant and site may be used for other purposes. Two prototype commercial reactors and the Armenian plant have already been shut down for good. More nuclear plants will be shut down as their operating life comes to an end.

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J.L. Fournie, C. Alary, M. Jean, D. Maire, and G. Peyrard, Novatome, Lyon, France

**Influence of Design Features on Decommissioning of a Large Fast Breeder Reactor**

EUR-12991; 75 pp. (1990)

In the conception and realization studies of a

Large Mass Fast Breeder Reactor, the decommissioning aspects are not much taken into account. It appears that low cost and unsophisticated dispositions can facilitate decommissioning; therefore the objective of this research is the identification of the concepts and construction measures, primarily those requiring low cost and low technological development, that can facilitate decommissioning operations.

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R.J. Francis, United Kingdom Atomic Energy Authority, Decommissioning and Radwaste Division, Harwell, United Kingdom

**Decommissioning Policy: Principles and Practices in the UK and Other European Countries**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (15 pp.) (August 1991)

An overview is presented of decommissioning arrangements and implementation as practiced by European member states of the International Atomic Energy Agency (IAEA). Principles and practices are outlined by summarizing how the United Kingdom is currently decommissioning nuclear facilities including research reactors and by reviewing European points arising from an IAEA study on policies and regulations in some member states. Information is given under the headings of regulatory framework, documentation, project management, strategic and planning considerations, and overall European approach and conclusions.

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**Experience and Advice Derived from Current Research Reactor Decommissioning in the UK (WAGR, DIDO, PLUTO, GLEEP)**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (18 pp.) (August 1991)

Experience and advice arising from four current United Kingdom (UK) research reactor decommissioning projects is presented, by first briefly describing the reactors and the decommissioning objectives. Key points are then summarized under headings used in the paper "Decommissioning Policy: Principles and Practices in the UK and other European Countries". These headings include (1) Summary of Example Projects; (2) Regulatory Framework; (3) Documentation; (4) Project Management; and (5) Strategic and Planning Considerations. This paper is intended to assist those involved in the planning, optimization, and implementation of decommissioning projects for research reactors and other small nuclear facilities.

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G.R.H. Fry, Massachusetts Department of Public Utilities, Electric Power Division, Boston, MA

**The Cost of Decommissioning U.S. Reactors: Estimates and Experience**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 7; (pp. 87-104) (1991)

Decommissioning is in its infancy, but our cost experience includes several dozen small, experimental reactors plus the 72 MW(e) Shippingport reactor. Decommissioning is just beginning at larger reactors, but the insights already accumulated allow some use of this experience in future estimates. This chapter compares generic cost estimates plus the data for a total of 21 closed reactors. Despite the common assumption about the efficiencies that will come with more decommissioning experience, the author finds a complete lack of scale economies. This finding could have implications for rates of collection, sufficiency of accumulated funds, and equity issues tied to future generations.

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## JPDR Decommissioning Program: Experiences and Recent Progress

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 206-232) (April 1990)

The Japan Power Demonstration Reactor (JPDR) decommissioning program has been conducted by the Japan Atomic Energy Research Institute (JAERI) since 1981 under a contract with the Science and Technology Agency of Japan. This presentation is an overview of activities to date at the JPDR. After the Phase I development period (1981-1986), Phase II, the actual work of dismantlement of JPDR, began in December 1986. Highlights from the FY 1989 activities are the cutting of the reactor internals and connecting pipes. Two types of underwater plasma arc cutting devices were adapted to dismantle metal structures in the reactor vessel. Spheroidal Graphite Cast Iron shielded containers were prepared for the 200 tons of relatively high (greater than 0.1 uCi/g) solid radioactive waste from JPDR operation. Two kinds of cutting techniques were adapted to cut pipes connected to the reactor vessel, a rotary disk knife system and a shaped explosive cutter. A code system called COSMARD is used in conjunction with a data acquisition system at the entry control gate to estimate management data such as manpower, worker exposure, waste amounts, and activity costs relating to decommissioning. Experience with COSMARD is used to develop the application of a data base to large-scale commercial nuclear plant decommissioning. In FY 1990, the pressure vessel and biological shield will be dismantled and the removal of equipment in the turbine building will begin.

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K. Fujiki, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

## Quarterly Report of JPDR Decommissioning Program - 1st Quarter FY 1990

Progress Report; 29 pp. (June 1990)

This report summarizes the progress of the Japan Power Demonstration Reactor (JPDR) decommissioning program during the first quarter (April-June) of FY 1990. Major items of dismantling work performed during this quarter are (1) removal of the reactor pressure vessel, (2) removal of the components in the turbine building, (3) decontamination of the dismantled components, and (4) recycling of the decommissioning waste. Items (1), (3), and (4) were continued operations; (2) was initiated during this quarter. Included with the report is a figure showing an isometric view of the JPDR. Work planned for the second quarter (July-September) of 1990 includes continuation of items (1), (2), (3), and (4), as well as the beginning of (a) removal of the biological shield concrete and (b) removal of the components in the reactor enclosure.

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K. Fujiki, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

## Quarterly Report of JPDR Decommissioning Program - 2nd Quarter FY 1990

Progress Report; 26 pp. (September 1990)

This report summarizes the progress of the Japan Power Demonstration Reactor (JPDR) decommissioning program during the second quarter (July-September) of FY 1990. Major items of dismantling work performed during this quarter include (1) removal of the reactor pressure vessel, (2) removal of components in the reactor enclosure, (3) removal of components in the turbine building, (4) decontamination of the dismantled components, and (5) recycling of the decommissioning wastes. All five of these operations were continued from a previous quarter. This report includes a figure showing an isometric view of the JPDR. Work scheduled for the third quarter of 1990 includes (a) dismantling of the bottom part of the RPV using a gas cutter; (b) dismantling of the biological shield concrete to start using a diamond sawing and coring system; (c) dismantling of the turbine, generator, and other turbine building components; (d) decontaminating components such as feed-water and heat-removal pipes using electropolishing or sulfuric acid-cerium (IV) techniques; and (e) continuing of melting and casting experiments using nonradioactive metals.

**168**

B. Gasc, Commission of the European Communities, Luxembourg

**Expanding to Teleoperation of a Tight Modular Workshop for Dismantling Radioactive Components**

EUR-12604; 45 pp. (1990)

The CEA (French Nuclear Energy Commission) in connection with Technicatome developed a tight modular workshop for the dismantling of AT1 plant facilities in La Hague. This workshop, constructed of reusable stainless steel panels assembled by bolting, provides a tight and decontaminable working zone that is compatible with any building configuration. This being the case, the operators wearing ventilated suits may work under the best safety conditions on alpha-contaminated materials. For the purpose of expanding the capacity of this workshop it was decided to develop special components for teleoperation from the outside as in a conventional cell. To meet this objective, which is within the scope of the contract signed with the Commission of the European Communities, the following components were developed and constructed: (1) manipulator holder panel, (2) swivelling hatch panel, (3) wall equipment sealed transfer device, and (4) modular biological protection. The design, construction, and testing of these new components led to their qualification and further incorporation into the list of components of the modular workshop to be used for teleoperation procedures.

**169**

J. Gaunt and N. Numark, International Bank for Reconstruction and Development, Industry and Energy Department, Washington, DC

**Decommissioning of Nuclear Power Facilities**

Report; 37 pp. (1990)

This report considers the pros and cons of the following options, mainly from the perspective of the United States: (1) continuing surveillance and maintenance, (2) entombment, and (3) dismantling and disposal of the radioactive components.

**170**

L.G. Geens, L.P. Geens, and I. Vandeven, Belgoprocessnv, Dessel, Belgium

**Processing of LLW Arising from Dismantling Activities in a Reprocessing Facility**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 359-362) (1990)

The Eurochemic reprocessing facility at the Mol-Dessel site in Belgium was in active operation from July 1966 until January 1975. In total, about 210 Mg of various types of irradiated nuclear fuels were processed. After the shutdown the plant was partially decontaminated in view of recommissioning. When the recommissioning option was abandoned, the decision was reached in 1986 to dismantle the plant. A 2-year study resulted in the start of a pilot project: the dismantling of two smaller buildings previously used for storage of uranyl nitrate and used solvent. The minimization of radioactive waste generation was also one of the major goals of this project. The report deals with the different steps in the minimization of radioactive waste generation during the dismantling activities. First, an estimation of the amounts of radioactive waste expected to be generated was made. In a second step the actual waste production during dismantling operations was minimized and compared with the estimations. Finally, a large part of the primary radioactive dismantling waste has been completely decontaminated, resulting in much lower amounts of nuclear waste generated.

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**Decommissioning of Final Product Storage Buildings at a Former Reprocessing Plant**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 210-217) (April 1990)

This paper discusses the final results of a pilot dismantling project, carried out at the former Eurochemic reprocessing plant in Dessel, Belgium. The pilot project consisted of the dismantling of two rather small storage buildings used for storing final products from the reprocessing process. The aims of the project were to verify the assumptions made in a previous study on dismantling and to demonstrate the development of dismantling techniques and the training of personnel. This report deals mainly with the generation of radioactive dismantling waste and secondary waste, the required staffing resources, and the costs of the dismantling project.

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**Organization and Rational Control of Decommissioning Operations: STMI - An Expert Enterprise**

CONF-8803283; Decommissioning of Fuel Cycle Nuclear Facilities, Proceedings of a Meeting, Paris, France, March 15, 1988. Societe Francaise d'Energie Nucleaire, Paris, France, 301 pp.; (pp. 29-46) (1988)

The decommissioning of a nuclear facility is typical of industrial operations when the different steps are considered: (1) definition of purpose, (2) financial plan, (3) operations planning, and (4) contract and operations control. However, because of the nuclear nature of the operations, unique conditions are present. The Societe des Travaux en Milieu Ionisant (STMI) enterprise has already performed decommissioning operations. The experience acquired must be followed by (a) rational actions, the first step leading to the classification of the priorities; (b) investigations leading to the operations planning, to the safety report, and to the contract; and (c) by the decommissioning operations. These actions are the subject of this paper.

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**The Feasibility of Recycling Activated Steel First Wall/Blanket Materials from Fusion Reactors**

Fusion Engineering and Design 11:423-440 (1990)

Process routes are outlined for conversion of radioactive steel scrap from fusion reactors to feedstock for the production of new components, with the requirement that the amount of radioactivity leaving the system be minimized. The proposed route comprises vacuum induction melting, followed by continuous casting or powder production and compaction using isostatic techniques. It is considered that reprocessing is feasible provided the contact dose rate of the material is below 25 mSv per hour. A storage time of about 70 years would be required for low-activation steels of currently anticipated compositions to attain this value. Active secondary wastes will be generated at all stages; some of these can be recycled to the melting unit, while others will require disposal. The fraction of the initial radioactivity retained in the recycled material varies from about 80-95%, depending on the starting composition and the extent to which transmutation-induced changes may need to be compensated for during remelting.

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**Decommissioning of the Princeton-Penn Accelerator**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 441-445) (1990)

The Princeton-Pennsylvania Accelerator operated on the Princeton University Campus from 1962 to 1972 prior to being dismantled. The Accelerator Building was left with two large areas of activated concrete in a floor up to 6 ft thick. A decommissioning plan was filed with the New Jersey Bureau of Environmental Radiation, and work commenced upon approval. Even though the activated concrete was very low-level, the economics of waste burial dictated a technical approach whereby the radioactive concrete was "surgically" removed so that the remainder of the structure could be released for unrestricted use. The exact area and depth of concrete to be cut was predicted by the SPAN-4 code. A diamond wire saw was used to cut out precise concrete blocks that were fitted into custom-sized shipping containers. This approach was successful in that the planned cut was within 5% of the actual volume removed to meet the release criteria and the majority of the structure could then be treated as an ordinary demolition project.

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**The Effect of Earthquake on a Decommissioned Nuclear Power Plant During Sinking into Subsoil**

Beton- und Stahlbetonbau 85(9):221-227 (September 1990)

In addition to a study of the planned dismantling of decommissioned nuclear power plants, a feasibility study was carried out to gather information about the security, the technical practicability, and the long-time radiation protection of the waste disposal by sinking into the subsoil. Because of the variable situation of the foundation during the sinking process, a statement about the earthquake loads on the structure has to be made. The emphasis lies on the nonlinear load-deflection relationship of the soil at the beginning of the sinking process, and the calculation of the loads on the shell caused by nonuniform excitation of the structure in the final position.

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**Principles in Disposing of Decommissioning Waste Together with LLW and ILW in Loviisa Nuclear Power Plant**

CONF-890544; Radioactive Waste Management, Proceedings of an International Conference, Brighton, United Kingdom, May 2-5, 1989, 356 pp.; (pp. 107-110) (1989)

In Finland, low- and intermediate-level waste from the operation and decommissioning of the nuclear power plants will be ultimately disposed of in two underground repositories to be built at the power plant sites. The Finnish Centre for Radiation and Nuclear Safety approved, in 1988, the preliminary safety analysis report for the disposal of low- and intermediate-level operational waste in Loviisa. Disposal of decommissioning waste in the same repository will need a separate licensing before decommissioning of the power plant.

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**Abrasive Waterjets - An Adaptable Tool for Different Purposes in Hazardous Environments**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 28-34) (April 1990)

An increasing number of technical operations have taken place in inaccessible environments (e.g., offshore structures) or hazardous environments (e.g., nuclear facilities). When these facilities are dismantled and decommissioned, specialized tools are required to ensure that neither the operating staff nor the environment are exposed to dangerous levels of radiation. This paper describes the research work being done to develop such a tool, the abrasive water jet. This nonthermal cutting tool uses small mineral particles accelerated by a high-speed water jet to cut virtually any kind of material. Some advantages of the abrasive-water jet technique over conventional methods are (1) the cutting tool does not come into contact with the surface to be cut, (2) the amount of force used to cut the material is relatively small (for the manipulator), (3) the tool is lightweight, (4) there is no fire risk because the cutting process is nonthermal, (5) there are no chemical reaction products, (6) all kinds of materials can be cut, (7) only a small amount of radioactive waste is produced when cutting activated structures, and (8) it is possible to both cut and clean with abrasive water jets. The abrasive water jet technique is not flawless, though, and research shows that its efficiency can be increased by slightly altering existing uses. To ameliorate the decrease in efficiency produced by underwater ambient pressure, it is necessary to use a focusing nozzle of correct diameter. To increase the working distance of the underwater jet, a larger focusing nozzle with an increased diameter is used. Also, it is possible to increase the working distance of the tool by air-coating the jet.

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**Experience in Testing Remotely Operated Manipulators in Nuclear Power Plant Demolition - Demolition of Niederaichbach Nuclear Power Plant**

ATW, Atomwirtschaft, Atomtechnik 36(1):43-46 (January 1991)

The high dose rate in the Neideraichbach reactor requires that dismantling work be performed by remotely operated manipulators. These remote handling devices are tested on a scale model and examined by expert consultants to check their proper functioning before they are used in the plant dismantling operations.

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**Research into the Melting/Refining of Contaminated Steel Scrap Arising in the Dismantling of Nuclear Installations**

EUR-12605; 93 pp. (1990)

The main part of the report is concerned with the steel-making behavior of various radioisotopes encountered in steel from decommissioning of nuclear installations (e.g., cobalt-60, cesium-134, and europium-154). Under a wide range of conditions, cobalt is largely absorbed by the steel, and europium is absorbed by the slag, whereas cesium may be largely volatized or largely absorbed by the slag. Radiation exposures that might occur during a large-scale recycling operation, during routine operations and accidents would not be significant according to published criteria in the United Kingdom. The second part of the report concerns the detection of radioactive materials which may be accidentally delivered to steelworks in scrap steel and used in steel-making. Detectors have been developed which would indicate the presence of radioactivity in scrap. A survey of the steelworks revealed areas where detection might be performed. Experiments have shown that a gamma ray detector of large volume could provide useful sensitivity of detection.

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### Method of Dismantling Radioactivated Shielding Concretes in Reactor

Japanese Patent JP 2-195300/A; 6 pp. (August 1, 1989; January 25, 1990)

An arm support is disposed to a lifting device disposed above a shielding body of a boiling water reactor-type reactor. A telescopic multijoint arm is attached rotatably to the arm support, and a cutter is attached to the top end thereof. The cutter is placed to an optional position of biological shielding concrete walls in reactor shieldings by a remote control while extending and rotating the arm, and the biological shielding concrete walls are cut. Then the cutter is replaced with a dismantled-piece-gripping machine and dismantled pieces are gripped and taken out by the dismantled-piece-gripping machine through the operation of the arm. This can widen the cutting range of activated biological shielding concrete walls, make the dismantling operation efficient, and shorten the operations term for dismantling.

**181**

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### Decommissioning of Nuclear Ship 'Otto Hahn'

Dekomisshoningu Giho 2:7-15 (June 1990)

The nuclear powered ship, Otto Hahn, was commissioned in 1968 and ended its mission in 1979. The decommissioning was approved in December 1980, and after the dismantling and removal of the reactor plant were completed, the decommissioning was carried out in September 1982. The primary features of the method used to decommission Otto Hahn were the removal of the reactor pressure vessel along with the primary shielding tank as one body, and, after the machinery, equipment and structures in the controlled area were removed or decontaminated, the reconstruction of the ship as a diesel freighter. The method used to decommission Otto Hahn and the data obtained from this effort furnish information for the decommissioning of nuclear power stations and of other nuclear powered ships. The propulsion plant of Otto Hahn, its radiological condition, the conceptual design of the decommissioning, the dismantling work, the permission and approval procedures, the procedure for removing the control, the execution of decommissioning, and the removal of the controlled area are reported.

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J.G. Hewlett

### A Cost Benefit Perspective of Extended Unit Service as a Decommissioning Alternative

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 20; (pp. 255-272) (1991)

Some consider life extension and license renewal as alternatives to decommissioning. The reasons for the popularity of such alternatives include presumed cost effectiveness, retention of scarce power plant sites, and the continued ability to pass on waste storage expenses as a cost of service. In this chapter the author addresses the common utility presumption that life extension of a nuclear power plant will allow it to produce electricity at a lower rate than new coal generation. The author argues that this presumption may not be supportable by analysis. He concludes that the deferral of constructing new replacement capacity would result in cost savings only if both the level and escalation rate of the operating costs for the refurbished unit fall substantially from 1986 levels. Thus it is unclear whether the deferral of the construction of new capacity would result in cost savings, although it definitely shifts the financial burden into the future.

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**Financial Implications of Early Decommissioning**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 22; (pp. 279-291) (1991)

There are three generalized timing possibilities for decommissioning: (1) at the end of the original operating license, (2) after some period of life extension, or (3) sometime before the end of normal service. This chapter is concerned with the third option. Premature decommissioning can arise from an accident (as it did for Unit 2 of Three Mile Island), or because it may be cheaper to close the facility than to have it continue in operation. The economic implication of premature closure is one of potentially insufficient fund accumulation. The decision to close a plant is complicated by decommissioning decisions; for example, the decision could depend in part on the status of the accumulated funds. Such a decision also can influence plans for new construction since it may delay the time of closure for existing plants. State regulatory bodies in the United States influence decisions through their control over rates of return. In the end, decommissioning cost considerations often influence decommissioning timing.

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**Managing Qualified Nuclear Decommissioning Trust Funds Under Uncertainty**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 15; (pp. 191-216) (1991)

Funds for the eventual decommissioning and removal of nuclear power plants are accumulating. The amount will total many tens, perhaps hundreds of billions, of dollars. One of the ingredients in setting aside these funds is managing them to assure that just enough cash is on hand at the time of decommissioning to meet all required expenses at the lowest possible net present value cost to utility ratepayers. As with any investment, there can be a variety of opinions. For this reason, it is important to consult several sources for advice on the investment of such nuclear decommissioning trust funds (NDTs). This author stresses the importance of an adaptive approach, pointing out that the most difficult question is the choice of investment maturities. By employing a simulation methodology to quantify the risk-cost characteristics of strategies along the maturity spectrum, the author concludes that the steepness of the municipal yield curve can be exploited even in the presence of inflationary uncertainty.

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**The Removal of Concrete Layers from Biological Shields by Microwaves**

EUR-12185; 42 pp. (1989)

Concrete blocks reinforced with steel bars have been subjected to microwave attack at a frequency of 896 MHz at power levels up to 25 kW(e). The surface concrete has been explosively removed to the depth of the reinforcement (10 cm) at a rate of about 2 l/kW(e) hr. Heating was localized around the point of attack, with temperatures up to 300 deg C at the fractured face being attained. A simple mathematical model of the propagation and absorption of microwaves was used to estimate the temperature rise of concrete at microwave frequencies of 896 and 2450 MHz, at different power levels with and without the presence of reinforcing bars. This demonstrated that reinforcement is expected to significantly increase the temperature rise in the concrete between the irradiated surface and the reinforcement, and that near-surface heating should be more rapid at the higher frequency. There was reasonable agreement between predicted and observed temperature at the higher power levels. Further desk and laboratory studies are proposed before proceeding to a full-scale practical demolition machine, and the requirements for a prototype remotely-operated demonstration system have been identified. This consists of a static generator of high power (at least 50 kW(e)) transmitting microwaves via a steerable wave guide to a remote applicator mounted on a simple three-axis manipulator capable of traversing realistically large concrete test panels.

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### Ecological Aspects of Nuclear Power Plant Decommissioning

INIS-mf-12817; CONF-9003260; Economic and Ecological Aspects of Nuclear Power Development, Proceedings of a Conference, Tabor, Czechoslovakia, March 29-30, 1990, 115 pp.; (pp. 104-111) (1990)

Nuclear power plant decommissioning reduces the risk of accidents, but it produces a source of radioactive products that can be released into the environment and brings about radiation hazards for the staff. The principles are outlined which, if observed, can minimize the environmental impact of nuclear power plant decommissioning. Another aspect associated with decommissioning is the growth of the amount of radioactive waste with the increasing extent of disassembly of the technological and building equipment. The overall amount of wastes is comparable with that of wastes produced throughout the entire life of the nuclear power plant. The estimate for the Bohunice A-1 plant is 10,600 tons. A con'derable portion of this is low-level waste. The problems of decontamination, personnel protection from external irradiation, knowledge of the behavior of the radionuclides present in the materials, and legal conditions for the release of these materials for further use have not yet been resolved.

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### Decontamination for Decommissioning of Nuclear Power Reactors

IAEA-TECDOC-511; 102 pp.; (pp. 37-45) (June 1989)

As part of a program carried out in Czechoslovakia in connection with the decommissioning of the Nuclear Power Plant (NPP) A-1, a study has been conducted on the decontamination and possible reuse of the materials found therein. The objectives of this study were to select suitable decontamination agents, assess decontamination efficiency by use of ultrasonic and electrochemical techniques, and develop a computer code applicable for reuse of materials. The study focused on carbon steel surfaces of the secondary circuit and stainless steel of the explosive mixture combustion system of the NPP A-1. From a series of decontamination tests run with various solutions, it has been shown that decontamination efficiency could substantially be enhanced by simultaneous application of an ultrasonic treatment. Electrochemical decontamination of low-alloy steels showed that this technique can be applied for reduction of contamination to the levels suitable for unrestricted use. Electrolytes such as nitric, sulphuric, phosphoric, and oxalic acids were used. It has been confirmed that the time period necessary for decontamination depends mainly on current density and thickness of the layer to be removed. Electrochemical decontamination tests of stainless steel showed that anodic oxidation and regimes with reverse polarities were more effective than cathodic reductions.

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**Cost-Benefit Analyses for Decommissioning and Dismantling of Nuclear Power Stations - Do Cost-Benefit Analyses for the Recycling of Materials Lead to a Reduction of Clearance Levels?**

CONF-8611297 (Vol. 11); Radiation Protection Principles for Management of Solid Radioactive Waste, Proceedings of a Closed Meeting of the Strahlenschutzkommission, Gundremmingen, Federal Republic of Germany, November 6-7, 1986, Vol. 11, 223 pp.; (pp. 183-201) (1988)

According to International Commission on Radiological Protection provisions, radiation doses to the population are to be kept as low as possible on the basis of a justifiable relationship between additional expense for dose reduction and the radiological benefit. This paper examines whether this principle, which requires maximum conceivable limits of personal doses as a result of materials recovery from dismantling, ought to be reviewed and whether clearance levels for materials to be recycled have to be reduced. The cost-benefit assessments presented for various options take into account the cost involved for processing and recycling methods as well as the social burden of dose commitments. A comparison in terms of radiological safety is presented for ultimate disposal of material or meltdown of material subject to appropriate radiological measurement and surveillance.

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**The Technical History of the Three Mile Island Unit 2 Cleanup: Factors, Options and Decisions**

CONF-891108; Recovery Operation in the Event of a Nuclear Accident or Radiological Emergency, Proceedings of an International Symposium, Vienna, Austria, November 6-10, 1989. International Atomic Energy Agency, Vienna, Austria, 657 pp.; (pp. 525-540) (1990)

The Electric Power Research Institute has sponsored a technical history project to ensure that the logic and consequences of decisions made during the Three Mile Island Unit 2 (TMI-2) cleanup are available for future radiological accident recovery operations. The TMI-2 cleanup is examined in terms of (1) planning and management; (2) plant stabilization following the accident; (3) decontamination and dose reduction; (4) damaged core removal and shipment; (5) radioactive waste management; (6) personnel protection; and (7) the techniques and importance of gathering data. Many technical decisions reflected issues involving funding, public perception, and the regulatory environment. Each decision involved a choice between several strategies, for example: (a) manual or robotic techniques to defuel the reactor; (b) demineralization, evaporation, or solidification to process radioactive water; and (c) decontamination or dose reduction to support the other cleanup work. The most important technical influence on decision making was the relevant data available when a decision was made. In many cases, limited data or inaccurate assumptions about conditions were serious handicaps to both planning and operations. A central lesson of the TMI-2 cleanup is the importance of proceeding methodically to understand conditions, to develop a simple engineering approach to handle known conditions, and then to repeat this sequence until recovery operations are complete.

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**The EC Program on Nuclear Decommissioning**

Nuclear Europe Worldscan 11(1/2):42 (1991)

Since 1979, the Commission of the European Communities has been conducting nuclear decommissioning research and development

(R&D) via public organizations or private companies in the member states under shared-costs contracts, with the main aim being to reinforce the scientific and technical basis of decommissioning. R&D projects include long-term integrity of buildings and systems, decontamination for decommissioning, and treatment of specific waste materials.

**191**

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**Decontamination and Decommissioning of a Plutonium Fabrication Facility**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 377-383) (1990)

EcoTek, Inc. was contracted in July 1987 to manage an active project involving the decontamination and decommissioning (D&D) of a plutonium fabrication facility at Nuclear Fuel Services, Inc. (NFS) in Erwin, Tennessee. Approximately 10,500 sq ft of currently unused plutonium fabrication facilities are located in two separate buildings on the NFS-Erwin site. Waste processing strategy centers around decontamination and sectioning with an ultra-high-pressure water jetting system incorporating a recirculating medium; volume reduction in a high-capacity shear/baler; and material control accountability utilizing a five-station, active-passive neutron nondestructive assay (NDA) system. A stainless steel containment has been constructed to house the sectioning and decontamination station. This containment attaches directly to the shear/baler, which has been modified to encapsulate all surfaces subject to contamination. The NDA system consists of five stations: (1) pre-decontamination inventory, (2) decontamination assay, (3) nuclear safety and accountability monitoring system, (4) bale and drum counter, and (5) bulk mixed uranium-plutonium oxide assay system. Most of the waste consists of 136 gloveboxes containing process equipment. Additional sources are ventilation ductwork, piping, conduit, scabbled concrete, and soil. This paper presents a brief synopsis of the overall decommissioning approach, which received U.S. Nuclear Regulatory Commission approval on June 20, 1989.

**192**

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**A Process for Decontaminating Stainless Steels to Release Limits**

Nuclear Technology 85:66-73 (April 1989)

A regenerative process involving the use of a dilute solution of nitric (0.5 to 1.0 weight%) and hydrofluoric (0.05 weight%) acids was developed for decontaminating stainless steels (Type 304) to release limits. The solution is regenerated using a strong acid cation exchanger and may eventually be disposed of after processing through a strong base anion exchanger. The waste management aspect of the decontamination is thus limited to the disposal of relatively small volumes of spent cation and anion exchange resins. Application of the acidic reagent for 1 hr at 95 deg C to the surfaces of an obsolete irradiated fuel source basket from the Pickering Nuclear Generating Station resulted in the removal of metal exceeding 1 mm and a residual (beta and gamma) contamination below a target limit of 0.1 microcuries/sq m. A soak-tank system with associated purification, vapor handling, and auxiliary systems is proposed for performing full-scale decontaminations of the baskets.

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Y. Ikezawa, H. Matsui, C. Nakamura, and Y. Yokosuka, Japan Air Cleaning Association, Tokyo, Japan; Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Characteristics of Aerosol and Air Contamination Control in Reactor Decommissioning**

CONF-8904278; Air Purification and

Contamination Control, Proceedings of a Symposium, Tokyo, Japan, April 26-27, 1989; (pp. 197-200) (1989)

In Japan, the dismantling of commercial nuclear power plants will start in the late 1990s. The dismantling of reactor internals, reactor pressure vessels, and radiation shielding concrete will be noticeable from the viewpoint of protection from internal exposure. Remote underwater cutting, disk cutting, and controlled blasting will be used to reduce the dose to workers. Through practical experience of Japan Power Demonstration Reactor decommissioning, some parameters of size distribution, dispersion rate, and resuspension coefficient of radioactive aerosols generated during dismantling operation are discussed for dose evaluation. The local exhaust devices and temporary containment room with a high efficiency particulate air filter are also described.

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**Decommissioning Nuclear Facilities: International Overview**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (10 pp.); IAEA News Features 6:1-10 (June 1991)

This meeting handout is an International Atomic Energy Agency newsletter publication, an international overview of decommissioning. The newsletter features one page each on these aspects of international decommissioning as it is currently being designed and performed: (1) strategies and stages, (2) national approaches, (3) steps and tools, (4) radiation exposure and safety, (5) radioactive wastes, (6) financing, (7) international (interagency) cooperation, and (8) world facts and trends.

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International Atomic Energy Agency, Vienna, Austria

**Excerpt from the International Atomic Energy Agency's Program and Budget for 1991 and 1992**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (5 pp.) (June 1991)

This excerpt from the International Atomic Energy Agency budget contains these items relevant to Program C, Radioactive Waste Management, Subprogram C.3, Decontamination and Decommissioning of Nuclear Installations: (1) Project C.3.01, Development of Decontamination and Decommissioning Technology; (2) Project C.3.02, Project Planning and Management for Decommissioning Operations; (3) Project C.3.03, Decommissioning of Research Reactors and Other Small Non-Power Nuclear Facilities; (4) Project C.3.04, Decommissioning of Uranium Mining and Milling Facilities; and (5) Item C/62 a technical report assessing the rehabilitation, decommissioning, and disposal alternatives for a nuclear reactor after a serious accident.

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International Atomic Energy Agency, Vienna, Austria

**International Atomic Energy Agency Decontamination and Environmental Restoration Program**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (2 pp.) (June 1991)

This brief handout outlines the origins of the International Atomic Energy Agency (IAEA) Coordinated Research Program (CRP) on decontamination, environmental restoration, and management of the resulting waste. IAEA proposed the CRP to (1) make currently available cleanup techniques more efficient and economic and (2) further develop such techniques, procedures, and equipment within the framework of the Chernobyl Center for International Research (CHECIR). CHECIR was the result of a 1989 request from the government of the Union of Soviet Socialist Republics to the IAEA to assess the radiological consequences of the Chernobyl accident. The international team of scientists assembled by the IAEA to perform this task presented their assessments and recommendations at the International Conference on the Chernobyl Project, May 21-24, 1991, in Vienna, Austria, under the auspices of CHECIR.

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International Atomic Energy Agency, Vienna, Austria

**Summary Report of the First Research Coordination Meeting of the Coordinated Research Programme on Decontamination and Decommissioning of Nuclear Facilities - Phase II**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (35 pp.) (June 1991; December 1989)

A total of 19 participants from 16 member states took part in the first Research Coordination Meeting (RCM) of the International Atomic Energy Agency (IAEA) Coordinated Research Program (CRP). The meeting took the form of presentations by the chief scientific investigators on the research agreements and contracts with the IAEA for this CRP. The presentations are reviewed in Section 2 of this document, together with a summary of the IAEA program on decontamination and decommissioning. Participants at the meeting also had an opportunity to review a draft working document entitled "Future (Post-1990) Research and Development Needs (CRP) in the Decontamination and Decommissioning of Nuclear Facilities." Comments and observations of the reviewers are presented in Section 4 of this document.

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International Atomic Energy Agency, Vienna, Austria

**Summary Report of the Second Research Coordination Meeting of the Coordinated Research Programme on Decontamination and Decommissioning of Nuclear Facilities - Phase II**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (15 pp.) (June 1991)

A total of 16 delegates were in attendance at the Second Research Coordination Meeting of the Coordinated Research Programme on Decommissioning of Nuclear Facilities - Phase II. Twelve countries were represented: Canada, China, Czechoslovakia, Finland, France, Hungary, India, Italy, Japan, the Republic of Korea, Sweden and the United States of America. Observers from the Arab Atomic Energy Agency and the Commission of the European Communities were also present. The United Kingdom and the Soviet Union were unable to attend. This document contains brief summaries of each of the oral presentations given at the meeting. The first presentation was given by the Scientific Secretary of the Coordinated Research Programme, Mr. P.L. De. Next, the chief scientific investigators or their representatives described the progress achieved in their projects. Finally, observers gave presentations on various topics related to decontamination and decommissioning of nuclear facilities. The individual presentations are listed separately.

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International Atomic Energy Agency, Vienna, Austria

**The Regulatory Process for the Decommissioning of Nuclear Facilities**

IAEA Safety Series No. 105; 33 pp. (July 1990)

The objective of this publication is to provide general guidance to International Atomic Energy Agency Member States for regulating the decommissioning of nuclear facilities within the established nuclear regulatory framework. The guide should also be useful to those responsible for the decommissioning of nuclear facilities. The guide describes in general terms the process to be used in regulating decommissioning and the considerations to be applied in the development of decommissioning regulations and guidelines. It also delineates the responsibilities of the regulatory body and the licensee in decommissioning. The provisions of the guide apply to all facilities within the nuclear fuel cycle and larger industrial installations using long-lived radionuclides. For smaller installations, less extensive planning and regulatory control systems should be acceptable, The guide deals primarily with decommissioning after shutdown. Most provisions, however, are also applicable to decommissioning after an abnormal event, once cleanup operations have been terminated.

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International Atomic Energy Agency, Vienna, Austria

**Planning and Management for the Decommissioning of Research Reactors**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (47 pp.) (August 1991)

The objective of this document is to provide the necessary guidance on decision making, planning, and management for the decommissioning of research reactors. Today there are around 350 research reactors (including training, test and prototyope reactors, and critical assemblies) in operation worldwide. Half of them have been in service for more than 20 years. A large number of these reactors are located in developing countries that may not have the appropriate guidance on how to plan and manage the decommissioning after these reactors have reached the end of their useful operational function. This document (1) addresses the factors to be considered in the decision to decommission, (2) describes a typical planning process for decommissioning, (3) identifies the requirements that should be fulfilled before obtaining a decommissioning license from the appropriate regulatory authority, and (4) provides a brief overview of activities necessary for completing the overall decommissioning program. It is thus a planning document rather than a technology, regulatory or safety document. It does take these other factors into account, and detailed technological, regulatory and safety information can be obtained from other International Atomic Energy Agency publications. Although this document is dedicated primarily to the decommissioning of research reactors, it is expected that the information contained herein can be used in the planning and management of the decommissioning of other nuclear facilities such as radiochemical laboratories, hot cells, waste treatment and decontamination facilities, etc.

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M. Ishikawa, M. Kawasaki, and M. Yokota, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**JPDR Decommissioning Program - Plan and Experience**

Nuclear Engineering and Design 122(1-3):357-364; CONF-881115; Nuclear Power Plant Thermal Hydraulics and Operations, Proceedings of the Third International Topical Meeting, Seoul, Republic of Korea, November 14-17, 1988 (September 1990)

The Japan Power Demonstration Reactor (JPDR) decommissioning program was established to develop the necessary techniques for decommissioning of commercial power reactors in the future by the Japan Atomic Energy Research Institute. The JPDR decommissioning program consists of two major phases. Phase I started in

1981, aiming at developing a set of techniques necessary for reactor dismantling. Phase II, actual dismantling of JPDR using the techniques developed in Phase I, started in December 1986. The dismantling work began in the containment and the dump condenser buildings. After the peripheral components around the reactor were removed, dismantling of highly activated JPDR internals began during the period of January to March 1988, using the underwater plasma arc cutting system operated by a robotic manipulator. The effectiveness of various dismantling techniques developed in the JPDR decommissioning program has been verified through the actual dismantling activities.

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T. Itagaki, K. Matsuda, and Y. Sakata, Ishikawajima-Harima Heavy Industries Company Limited, Tokyo, Japan

### Method of Dismantling Reactor Core Structural Material

Japanese Patent 1-131495/A; 7 pp. (May 24, 1989)

Volume-reduction processing for zercaloy material from reactor core structures is conducted through decomposition by pyrometallurgy. Zirconium is recovered as zirconium oxide. Chromium, nickel, iron, etc. with residual radioactivity are made into slags and separated in a volume-reduced state. First, pure copper is brought to a molten salt. The surface of the copper bath is maintained in an inactive, nonoxidative atmosphere to suppress unnecessary reactions. Then the reactor core structural materials to be decomposed are charged into the pure copper bath, maintained at 1200-1300 deg C. A uniform molten bath is obtained up to Cu 80% - Zr. Then an oxidative reaction, mainly for zirconium, is promoted in a reducing atmosphere to form Zr. Free zirconium oxide is separated and removed as a result of its specific gravity relative to the copper bath. Oxidation with Cr, Fe, Sn, Ni, etc. is promoted in a oxidative atmosphere and their oxides float as a result of differences in specific gravity relative to the copper bath. The oxides form slags and are recovered for separation.

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C. Jaouen, Commission of the European Communities, Luxembourg

### Study of Large Size Fiber Reinforced Cement Containers for Solid Wastes from Dismantling

EUR-12563; 26 pp. (1990)

The production of large-sized metallic waste by dismantling operations and the evolution of the specifications of the waste to be stored in the different European countries will create a need for large standard containers for the transport and final disposal of the corresponding waste. The research conducted during the 1984-1988 program, supported by the Commission of European Communities, and based on a comparative study of high-grade concrete materials, reinforced with organic or metallic fibers, led to the development of a high-performance container that meets international transport recommendations as well as French requirements for shallow-ground disposal. The material selected, consisting of high-performance mortar with metal fibre reinforcement, was the subject of an intensive program of characterization tests conducted in close cooperation with LAFARGE Company, demonstrating the achievement of mechanical and physical properties comfortably above the regulatory requirements. The construction of an industrial prototype and the subsequent economic analysis served to guarantee the industrial feasibility and cost of this system, in which attempts were made to optimize the finished package product, including its closure system.

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Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

### JPDR Decommissioning Program Dismantling Information

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June

10-14, 1991, Vienna, Austria; (11 pp.) (June 1991)

This meeting handout is a visual presentation of the Japan Power Demonstration Reactor (JPDR) decommissioning program. The JPDR is briefly described, along with lists of the goals of the program and the dismantling techniques being used. Major dismantling activities are listed with their percent of completion toward the Stage 3 decommissioning level. A graph illustrates hydrogen concentration levels from supply gas during cutting of the core shroud. Another figure denotes concentration of radioactivity in the reactor pressure vessel water during underwater plasma arc cutting. There is an illustration of underwater shaped explosive cutting at JPDR, including peak pressure in the water (kg/sq cm) at distances from 0.1 to 10 meters. A comparison is made of required manpower to the unit weight of components dismantled, including loss of productivity as a result of congested work areas.

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Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Reactor Decommissioning Technology Development and Actual Dismantling of JPDR**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (19 pp.) (June 1991)

There have been only a few reactors decommissioned worldwide; reactor decommissioning technology, therefore, is not well established. The Japan Atomic Energy Research Institute (JAERI) has been developing needed techniques through dismantling the Japan Power Demonstration Reactor (JPDR). This handout is a March, 1990, JAERI publication giving an overview of the JPDR decommissioning technology development and actual reactor dismantling progress through the end of 1989. Included are (1) a schedule of planned and completed dismantling activities for 1981-1992; (2) a breakdown and description of eight major areas in reactor decommissioning technology development; (3) a chart with illustrations of the actual dismantling process at the JPDR; (4) a description of technology development items employed in actual dismantling; and (5) a brief report on international cooperation in decommissioning technology, including a world map of decommissioning projects participating in a cooperative program for information exchange. The technology development items employed in actual dismantling and briefly described here include (a) systems engineering; (b) nonintrusive measurement of radioactivity inside pipe; (c) radioactive inventory estimation; (d) removal of reactor internals using plasma arc cutting system; (e) removal of pressure-vessel piping using shaped explosive and rotary disk knife cutting techniques; (f) removal of pressure vessel using arc saw cutting system; (g) removal of biological shield concrete using diamond sawing and coring, water jet cutting techniques, and controlled blasting; (h) decommissioning waste treatment, storage, and disposal; (i) decontamination for reactor decommissioning; (j) radiation control; and (k) remote operation techniques.

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Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Progress of JPDR Decommissioning Program - Sixth Progress Report (October 1989-March 1990)**

Progress Report; 36 pp. (August 1990)

The Japan Power Demonstration Reactor (JPDR) decommissioning program was started in 1981 by the Japan Atomic Energy Research Institute under a contract with Japan's Science and Technology Agency. This report is the sixth progress report for the JPDR decommissioning program. It describes the JPDR dismantling progress and the related development of reactor decommissioning technology for the period October 1989 through March 1990. During this period, removal of the remaining reactor internals, the two control-rod-guide tubes, was completed using both shaped-explosive and plasma-arc cutting techniques. Removal of pipes connected to the reactor pressure vessel (RPV) was also finished using shaped explosives, a rotary-disk knife and conventional techniques. Following this operation, the installation and adjustment was performed on the underwater arc saw system for cutting the RPV. In parallel with this dismantling work, ongoing regular tasks of the JPDR dismantling continued, including decontamination of dismantled components and decommissioning waste management. Development of the code system for management of reactor decommissioning and research and development for reusing radioactive metal waste continued. All dismantling work was performed without significant difficulty and produced valuable data for future decommissioning efforts. JPDR continued international cooperation with several countries on reactor decommissioning technology.

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N.D. Jayawardene and P.D. Stevens-Guille, Ontario Hydro, Toronto, Ontario, Canada

**Strategy, Planning and Costing for Decommissioning in Canada**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 14; (pp. 181-188) (1991)

Ontario Hydro, the public-owned electric utility in Ontario, Canada, is one of the three largest nuclear utilities in the world. Decommissioning of its CANDU nuclear stations will begin about 2012 when the first station at Pickering is scheduled to be shut down after an operating period of 40 years. Other stations at Bruce and Darlington will be shut down and decommissioned subsequently. The cost of these operations is being charged to customers and is calculated using the annuity method. This chapter describes Ontario Hydro's decommissioning policy, financial planning and method of funding future decommissioning costs. One policy requirement is that future generations should not have to pay for decommissioning costs; deferring costs far into the future is not financially prudent. The current status of public opinion in Canada on decommissioning and radioactive waste management, including the tourism value of a decommissioned reactor, also is discussed.

**208**

B.S. John

**Decommissioning and Jobs**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 5; (pp. 87-112) (1990)

One aspect of the decommissioning web is its effect on socioeconomics, particularly jobs. What will reactor retirement mean to jobs, especially in rural communities where power plant operations may be the most reliable and dominant source of direct and indirect employment in the area? The problems that any plant closure produces for job security are generally understood, but the decommissioning of nuclear power plants is different because of the residual radioactivity and the greater isolation of the power plant sites. For example, what will be the specific employment effects of several possible decommissioning scenarios such as immediate dismantlement and delayed dismantlement? The varying effects of decommissioning on jobs is discussed. It is concluded that the decommissioning of nuclear power plants in some areas such as Wales could bring benefits to the surrounding communities.

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A. Jouan, Commissariat a l'Energie Atomique, Etablissement de la Vallee du Rhone, Bagnols-sur-Ceze, France; U.S. Department of Energy, Office of Environmental Audit, Washington, DC

**Dismantling and Decontamination of the PIVER Prototype Vitrification Facility**

CEA-CONF-10077; CONF-891077; Decommissioning of Nuclear Installations, Proceedings of the 1989 International Conference, Brussels, Belgium, October 24-27,

1989. Commission of the European Community, Brussels, Belgium; (14 pp.) (1989)

The PIVER facility was dismantled for replacement by a new continuous pilot plant. The more important operation concerns the vitrification cell, containing equipment of the process, for complete disposal and maximum decontamination (which requires dismantling, cutting, conditioning, and removal of equipment inside the cell). Manipulators and handling and cutting tools were used. Activity of removed material and irradiation of personnel are followed during the work for matching intervention means to operation conditions.

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C.H. Jung, H.J. Won, J.K. Moon, J.B. Shim, W.K. Choi, and W.Z. Oh, Korea Atomic Energy Research Institute, Seoul, Republic of Korea

**Spent Fuel Rod Decontamination**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (9 pp.) (June 1991)

A decontamination process with the reagent based on organic acids has been developed for the decontamination of the primary coolant system (including steam generator channel head) of a nuclear power plant. Previous tests at the Korea Atomic Energy Research Institute (KAERI) showed that this process has effective dissolution characteristics and no detrimental effect on structural materials. In this study, decontamination experiments were performed on spent-fuel rods using the KAERI decontamination process to evaluate the dissolution performance of the KAERI reagent and investigate the characteristics of crud deposited on pressurized water reactor spent-fuel rod surfaces.

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W.H. Junker, Bonn University, Rechts- und Staatswissenschaftliche Fakultaet, Bonn, Federal Republic of Germany

**Decommissioning, Safe Enclosure, and Dismantling Licensing for Nuclear Power Plants According to Section 7 Subsection 3 of the Atomic Energy Act**

Studien zum Internationalen Wirtschaftsrecht und Atomenergierecht. Heymanns, Koeln, Federal Republic of Germany, Vol. 82, 202 pp. (199C,

This report is concerned, from a legal point of view, with the systematic recording, classification, and assessment of specific problems concerning the post-operational phase of a nuclear power plant. The introduction deals with present experience with decommissioning in the Federal Republic of Germany. Part 1 treats the factual side of Section 7 III AtG and explains the mentioned terms related to licensing and priority relations. Part 2 deals with the preconditions for licensing pursuant to Section 7 III AtG. Part 3 is concerned with the legal consequences of Section III AtG, i.e. the extent of official discretionary powers, whereby aspects of radioactive waste management carry great weight. Part 4 discusses administrative and procedural particularities relating to licensing according to Section III AtG.

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B. Karderud and T.A. Stenberg, Vattenfall Energisystem AB, Nuclear Process Systems and Radwaste Engineering, Vallingby, Sweden

**Removal, Transport and Disposal of Reactor Pressure Vessels in One Piece from Swedish Nuclear Power Plants - SKB Study**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (28 pp.) (June 1991)

This paper gives a background and overview to the nuclear power program, radioactive waste management, and decommissioning in Sweden. It outlines the SKB company's one-piece reactor pressure vessel disposal study, which is divided into three parts. The questions the study answer include if, how, and where to dispose of the Swedish reactor pressure vessels in one piece. Currently, a Part 2 technical review of one plant (Forsmark 1) is ongoing, along with a cost analysis for one-piece removal of the reactor pressure vessel. This progress report goes into some detail on the achievements of Part 1 and 2 of the reactor pressure vessel disposal study. The study concludes that the one-piece method of dismantling, transport, and disposal of the Forsmark 1 reactor pressure vessel is realistic and cost-effective compared to total dismantlement. It also seems likely that the other reactor pressure vessels in Sweden can be handled in the same way. The study also concludes that, according to dose rate calculations, five years after shutdown it will be inappropriate to perform operations with the activated reactor internals that are necessary for one-piece removal. The study recommends a more detailed study, in conjunction with specialist contractors, of the heavy lifting and dismantling involved with one-piece reactor pressure vessel disposal. In Part 3, to be completed in 1993, a safety assessment of reactor vessel disposal in the to-be-constructed final repository for high-level radioactive wastes will be made. Also in Part 3, further investigations of techniques and costs will be made, ending with a final report.

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Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, Federal Republic of Germany

**Decommissioning of Nuclear Facilities and Power Reactors/Germany: Status 1991**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (20 pp.) (June 1991)

This report contains a decommissioning status report for each German nuclear facility and power reactor, current as of April, 1991. Also included are technical data, decommissioning sequence, and visual representations for each facility.

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Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, Federal Republic of Germany

**Decommissioning MZFR**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (23 pp.) (June 1991)

This report contains technical data and visual representations of the MZFR Nuclear Power Plant in Germany. The document includes (1) a visual overview of the plant, (2) a licensing sequence for facility decommissioning, (3) a time schedule for facility decommissioning, (4) an estimate of masses produced during decommissioning, (5) a schematic diagram of the reactor circuit, (6) an activity inventory of the reactor building, (7) a radioactivity inventory of the reactor pressure vessel, (8) a tritium inventory of the primary system, and (9) an estimate of the accumulated irradiation dose of the staff during the second decommissioning step.

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Y. Kihara, Y. Takahashi, and J. Ouchi, Power Reactor and Nuclear Fuel Development Corporation, Tokai, Ibaraki, Japan

**Dismantling and Removal of Mixed Conversion Technology Development Testing Facilities (2 kg MOX Facilities)**

Dekomisshoningu Giho 2:16-28 (June 1990)

At the Tokai Works, Power Reactor and Nuclear Fuel Development Corporation, the mixed conversion technology development testing facilities installed in Plutonium Fuel Development Laboratory No. 2 were dismantled and removed from January 1988 to January 1989. The contamination level of the facilities was high and the scale was large. Therefore, based on the dismantling and removal experience obtained so far, improvements to methods and strict work control were carried out, with emphasis on reducing the radiation exposure of workers. The 107 cu m glove box, which contains a variety of equipment and a greenhouse, was enclosed. The glove box and the equipment installed in it were decontaminated. Then workers wearing airline suits cut and dismantled the glove box and the equipment in the greenhouse. The coating separation method was adopted as the method of decontaminating the glove box. The work was completed without internal exposure and without exceeding the planned external exposure. The denitration facilities, the method of dismantling and removal, and the results are reported.

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H. Kim, S. Park, and W.Z. Oh, Korea Atomic Energy Research Institute, Seoul, Republic of Korea

**AISI 304 Stainless Steel and Inconel-600 in EDTA/Citric Acid/Ascorbic Acid Base Decontamination Solution**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (27 pp.) (June 1991)

This meeting handout is a visual presentation of potentiodynamic tests done on metals at the Korea Atomic Energy Research Institute (KAERI). Because most published data on corrosion behavior is obtained with weight-loss measurement and surface observation, the potentiodynamic test is a very important method in understanding corrosion behavior. KAERI researchers developed an EDTA/citric acid/ascorbic acid mixture for the decontamination of the steam generator of a pressurized water reactor. To understand the corrosion behavior of AISI 304 Stainless Steel and Inconel-600, cylindrical specimens in an "as received" state were placed in seven different solutions with pH adjusted to 2.8 by ion exchange. At 95 deg C, the EDTA solutions were deaerated with bubbling nitrogen and oxygenated with bubbling oxygen. Potentiodynamics (polarization curves) were plotted for both materials under the different conditions. Weight-loss measurement at an open circuit potential of 400 mV and 700 mV and a metallographic observation after weight-loss measurement were also made. Redox potentials were noted. Based on the results, the following conclusions were obtained: (1) the passive regions of AISI 304 stainless steel and Inconel-600 are located over the range of potential from -300 mV to 400 mV with passive current density of from 3-5 uA/sq cm; (2) corrosion current density was about 1-5 uA/sq cm and no pitting and intergranular corrosion were observed when potential was less than 400 mV; (3) EDTA, citric acid, and ascorbic acid do not exert an influence on both corrosion rate and passive region; and (4) anodic oxidation rates of chemicals on Pt increase with a sequence of citric acid, EDTA, and ascorbic acid. KAERI plans further studies on (a) decontamination of a whole spent-fuel rod, (b) decontamination of a large contaminated area at Chernobyl, and (c) development of a coating technology for radioactive waste vessels which is resistant to corrosion in a marine atmosphere.

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H. Klopfer, R. Engelfried, D. Ricken, and R. Schmidt, Dortmund University, Dortmund, Federal Republic of Germany

**Further Development of a Process for the Removal of Radioactively Contaminated Coatings from Concrete Structures when Shutting Down a Nuclear Plant by Using Shock Cooling - Final Report**

Report; 100 pp. (August 1989)

The existing method of applying liquid nitrogen to concrete surfaces for the removal of compound coatings has been improved, especially on vertical surfaces. A spray head for liquid nitrogen which uses a combined application of heat and cold was developed and tested. The new methods and equipment were used on concrete with various formulas of compound coatings developed specifically for the experiment. In this way the flexibility of the new liquid nitrogen compound-removal methods could be verified. A method of using microwaves in the coating removal process was also developed and tested in functional models. Experiments were conducted in which microwaves were used to create steam pressure within the concrete in an effort to remove the coating with little or no chipping of the concrete. Results of the microwave testing indicated that this might be possible. In addition, model coatings that are easily removed from concrete were developed and tested. A study conducted on the courses of stress in compound coating bodies gave insights to the mechanisms of removal.

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G. Knoedler, Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft, Stuttgart, Federal Republic of Germany

**Reactor Dismantling - Safety Regulations and Protective Measures**

IRB-1167; 36 pp. (1989)

This documentation, with comments and explanations, deals with the safety regulations and radiological protection measures to be observed in the dismantling of nuclear power stations.

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F. Komatsu and E. Seikosho, Kobe Steel Limited, Kobe, Japan

**Method for Soil Removal from Radioactive Metal Waste Surface**

K/TR 91/2; Japanese Kokai Patent HEI 1[1989]-295199; 31 pp. (1989)

The patent is for a method of soil removal from radioactive metal waste surfaces, characterized by spraying an organic acid solution on the outer surface of the metal waste surface to dissolve and remove the surface layer of contamination. This is followed by spraying water on the metal surface to form an oxide layer, then spraying organic acid solution on the oxide layer to dissolve and remove it and/or mechanically polishing the oxide layer, then using water to wash the contaminants and the dissolved oxide layer from the surface.

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G.J. Konzek and R.I. Smith, Pacific Northwest Laboratory, Richland, WA

**Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station: Comparison of Two Decommissioning Cost Estimates Developed for the Same Commercial Nuclear Reactor Power Station**

NUREG/CR-0672 (Add. 4); 71 pp. (December 1990)

This study presents the results of a comparison of a previous decommissioning cost study by Pacific Northwest Laboratory (PNL) and a recent decommissioning cost study of TLG Engineering, Inc., for the same commercial nuclear power reactor station. The purpose of this comparative analysis on the same plant is to determine the reasons why subsequent estimates for similar plants by others were significantly higher in cost and external occupational radiation exposure (ORE) than the PNL study. The primary purpose of the original study by PNL (NUREG/CR-0672) was to provide information on the available technology, the safety considerations, and the probable costs and ORE for the decommissioning of a large boiling-water reactor (BWR) power station at the end of its operating life. This information was intended for use as background data and bases in the modification of existing regulations and in the development of new regulations pertaining to decommissioning activities. It was also intended for use by utilities in planning for the decommissioning of their nuclear power stations. The TLG study, initiated in 1987 and completed in 1989, was for the same plant, Washington Public Supply System Unit 2, that PNL used as its reference plant in its 1980 decommissioning study. Areas of agreement and disagreement are identified, and reasons for the areas of disagreement are discussed.

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G.J. Konzek and R.I. Smith, Pacific Northwest Laboratory, Richland, WA

**Technology, Safety and Costs of Decommissioning Reference Light Water Reactors Following Postulated Accidents: Re-evaluation of the Cleanup Cost for the Boiling Water (BWR) Scenario 3 Accident from NUREG/CR-2601**

NUREG/CR-2601 (Add. 1); 51 pp. (December 1990)

The estimated costs for post-accident cleanup at the reference boiling-water reactor (developed previously in NUREG/CR-2601 of the same title) are updated to January 1989 dollars in this report. A simple formula for escalating post-accident cleanup costs is also presented. Accident cleanup following the most severe accident described in NUREG/CR-2601 (i.e., the Scenario 3 accident) is estimated to cost from $1.22 to $1.44 billion, in 1989 dollars, for assumed escalation rates of 4% or 8% in the years following 1989. The time to accomplish cleanup remained unchanged from the 8.3 years originally estimated. No reanalysis of current information on the technical aspects of TMI-2 cleanup has been performed. Only the cost of inflation has been evaluated since the original Pacific Northwest Laboratory analysis was completed.

222
D. Kovan

**Decommissioning Enters the Commercial Era**

CONF-900387; Decommissioning of Nuclear Facilities, Proceedings of the Second International Seminar, London, United Kingdom, March 19-20, 1990, 405 pp.; (pp. 9-12); Atom 405:9-12 (July-August 1990)

Judging by some stories that have appeared in the press, the public could be excused for thinking that it was decommissioning that ultimately forced the government to retain nuclear power in the public sector. The development of this confusion formed the backdrop to the discussions reported here.

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M. Kucerka and J. Leicman, Federal Ministry of Fuels and Energy, Prague, Czechoslovakia; CSFR, Prague, Czechoslovakia

**Getting on with Dismantling at Czechoslovakia's Bohunice**

Nuclear Engineering International 35(434):28-29,32-33 (September 1990)

In spite of a design not developed for ease of decommissioning, a radiological situation seriously worsened by an accident, and a cladding corrosion problem, the step-by-step decommissioning of the first Czechoslovak demonstration plant is going ahead, and the resulting radioactive wastes are being processed and disposed of. The process is described.

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M. Kyrs and A. Moravec, Ustav Jaderneho Vyzkumu, Rez, Czechoslovakia

**Selected Problems of Minimization and Management of Radioactive Wastes from Nuclear Power Plant Decommissioning - Part 2**

UJV-8420-CH; 22 pp. (June 1988)

The processing prior to storage of radioactive wastes produced in nuclear power plant decommissioning is described, as are the types of containers employed for waste transport and/or disposal. Data are summarized on exposure of personnel to radioactivity resulting from nuclear power plant decommissioning activities, and accessible data are collected on the costs of nuclear power plant decommissioning and of waste management. Potential directions of research in this field under Czechoslovak conditions are specified. Part 1 was published in this same series as report UJV-8410-CH (May 1988).

225
T. LaGuardia, TLG Engineering, Inc., Bridgewater, CT

**A Private Contractor's Approach to Decommissioning Costs**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics:

Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 12; (pp. 157-171) (1991)

Generic cost estimates are important in giving a general impression about the magnitude of the overall task of decommissioning. Site-specific cost estimates, however, are necessary for each individual power plant so that differences in design, site, and history will be reflected as accurately as possible. This chapter gives a view of cost estimates which will be valuable to the utility operator who wants to know whether an estimate is adequate without being overinflated, to the regulator who is responsible to the citizens, and to the public who ultimately pay the bills. Various types of contracts such as fixed price, time and materials, cost-plus-fixed-fee, and utility-to-decommissioning operations contractor fixed price are discussed. The use of fixed-price contracts for subcontractors and a cost-plus-fixed or incentive fee for the primary contractor is recommended. The need for site-specific estimates is stressed.

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M.E. Lapides, Electric Power Research Institute, Palo Alto, CA

**The Projected Influence of Extended Unit Service**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 21; (pp. 273-278) (1991)

If the operational life of a nuclear power plant can be extended, decommissioning will be delayed. In effect, this is an alternative to decommissioning. In this chapter the author evaluates the cost, environmental consequences, and funding impacts of delaying decommissioning for 20 to 30 years. He concludes that the impacts of decommissioning on any of these three categories will be insignificant to the decommissioning decision.

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**The Three Mile Island Unit 2 Reactor Building Gross Decontamination Experiment - Effects on Loose Surface Contamination Levels**

Nuclear Technology 87(2):407-420 (October 1989)

In March 1982, the gross decontamination experiment was conducted in the Three Mile Island Unit 2 reactor building (RB). The intent of the experiment was twofold: (1) to determine which of several commonly used decontamination techniques would be the most efficient at reducing contamination levels on vertical and horizontal surfaces and (2) to actually reduce radiation and surface contamination levels in the accessible areas of the RB (to reduce person-rem expenditures for future entries). Accessible areas included the entire RB except inside the D-rings, inside the enclosed stairwell, and at the 282-ft elevation. The experiment consisted of six separate tasks that were implemented in nine different major work packages, accomplished during 15 RB entries over a 30-day period. Approximately 0.4 person-Sv was expended in completing the experiment. In spite of operational deviations from the original plan and the lack of emphasis on pre- and post-test data acquisition, the average RB contamination levels dropped by a factor of 10 and the most effective decontamination techniques were determined. Decontamination factors of 1 to approximately 125 were achieved.

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**Decommissioning of Nuclear Installations**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 141-146) (April 1990)

This conference paper gives an account of research being done on the dismantling of nuclear facilities by use of the plasma arc cutting technique. Plasma arc cutting has several advantages over conventional means of cutting: lower tool reactions, reduced torch size, and high-speed cutting capabilities. Research and development tests of the plasma arc tool are relative to its use under variable conditions (working parameters, remote piloting, cutting environment, radioactive or nonradioactive materials, and maintenance). An assessment of the secondary emissions (gases and aerosols) produced by the technique is given, and the nature and concentration of the different gases and aerosols as well as the size distribution of the latter are defined.

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**Nuclear Power Plants Decommissioning in France: Definitions and Responsibilities Concerning Regulations**

CONF-8803283; Decommissioning of Fuel Cycle Nuclear Facilities, Proceedings of a Meeting, Paris, France, March 15, 1988. Societe Francaise d'Energie Nucleaire, Paris, France, 301 pp.; (pp. 6-16) (1988)

Unlike those in Germany and in the United States, the safety regulations in France for the decommissioning of nuclear facilities are not defined. Safety regulations as applied in a special application of a general regulation based on the December 11, 1963, modified decree are discussed. The decommissioning operations, for which several possibilities have to be considered, are reviewed and specified. The experience acquired in this field is reviewed.

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**Abrasive Water Jet Cutting - Remote Hot Cell Application**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 180-182) (1988)

In the process of selecting a failed-equipment cut-up tool for the process facility modifications project at the Hanford site, a system using an abrasive water jet was developed and tested for remote disassembly of failed equipment. It is presented in this paper.

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**Decommissioning of NPD Generating Station**

INIS-mf-12827; CONF-880662; Proceedings of the 28th Annual Conference of the Canadian Nuclear Association and the Ninth Annual Conference of the Canadian Nuclear Society, Winnipeg, Canada, June 12-15, 1988, 488 pp.; (pp. 194-196) (1988)

The Nuclear Power Demonstration (NPD) generating station at Rolphton, Ontario began operating in 1962. It was intended to demonstrate the practicability of producing electricity with the CANDU reactor design. A pressure tube removed in 1987 showed hydrogen concentrations high enough to cause concern for the mechanical properties of the other tubes. When it was found that the problem was widespread, it was decided to shut the reactor down. The decommissioning of NPD is to be carried out in three stages: (1) final operation - the removal of all fuel and heavy water and shutting down all systems; (2) static state - a period of about 50 years of radioactive decay when the site will be unstaffed but monitored remotely; and (3) ultimate disposal - either all radioactive material will be removed to a permanent repository or the existing structure will be filled with concrete, sand or other material. The final operation stage is expected to be complete by September 1, 1988.

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**Decommissioning Cost Estimates: A Rational Approach - Employing a Validated Computer Code**

INIS-mf-12827; CONF-880662; Proceedings of the 28th Annual Conference of the Canadian Nuclear Association and the Ninth Annual Conference of the Canadian Nuclear Society, Winnipeg, Canada, June 12-15, 1988, 488 pp.; (pp. 202-209) (1988)

Decommissioning cost estimating is receiving an increasing amount of attention. Estimates prepared to date, as drawn from the published literature, have displayed a rather wide variability, due in great part to the absence of a logical, rational approach to cost estimation. This paper puts forward a suggested approach based on the Unit Cost Factor (UCF) method. It further suggests that computerization of the estimation process provides significant benefits and flexibility. The AECL-DECOM computer code for decommissioning cost estimation is described in the context of the recommended approach. Two case studies, the Gentilly-1 and the Nuclear Power Demonstrator Reactor decommissioning projects, are described, as are the efforts made to date to validate the code on these projects. A reasonably good correlation has been achieved and improvements have been made based on the experience gained. It is concluded that a rational, logical, validated code such as AECL-DECOM is a valuable tool for the preparation of reliable, defensible decommissioning cost estimates.

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**Dismantling and Total Demolition of the Niederaichbach Nuclear Power Plant (KKN)**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (3 pp.) (June 1991)

The Niederaichbach Nuclear Power Plant was designed for a nominal power output of 100 MW(e) and built near Landshut, Bavaria, from 1966 to 1972. From 1972 to 1974 the plant was operated for 18 full power days with 40% of its nominal power. For economic and technical reasons the plant was closed in 1974. In the first decommissioning step, the safe enclosure, fuel elements, and the plant media were removed, and the radioactive inventory was enclosed in the safety containment. In the second decommissioning step the plant will be dismantled and demolished with the objective of restoring the area to a "green field" condition. The decommissioning plan is divided into five steps: (1) manual in-place dismantling of the nonradioactive systems; (2) manual in-place dismantling of the contaminated system; (3) dismantling of the activated moderator tank, including its internals, and of the thermal shielding using remote handling devices; (4) dismantling of the activated inner zone of the biological shield by precision blasting (the preparations and the final work will be done by hand) and of the remote handling devices, and decontamination of the buildings in the controlled area; and (5) conventional demolishing of the buildings. The dismantling team will consist of about 70 persons. The cost of the project is expected to be around 100 million Deutschmarks.

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**Tools and Cutting Techniques for Dismantling Operations**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the

International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (16 pp.) (June 1991)

Several tools and techniques for dismantling nuclear reactors are described in basic detail. These include (1) plasma arc cutting (both underwater and in air), (2) laser cutting, (3) arc saw cutting, (4) high-pressure water jets with abrasives, and (5) fissuring. Section F is devoted to brief descriptions of five other lesser-used methods, including (a) arc-air, (b) explosives, (c) angle grinder, (d) reciprocating saw, and (e) hydraulic pipe shears. Each technique is critiqued, and its advantages and disadvantages are outlined.

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**Decommissioning Plans and Costing in Germany**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 13; (pp. 173-180) (1991)

Prior to reunification, within the borders of the Federal Republic of Germany there were seven reactors of different types and at various stages of decommissioning or planning. This chapter highlights several factors which influence economic costs, including timing of dismantlement, site-specific features, lack of final repository, licensing framework, and political scenarios. It is apparent from this discussion that procedures, timing, key considerations, reasoning, and ultimate goals regarding decommissioning are similar from one country to another, with most countries facing similar challenges at about the same time. Although this means that each country can learn from the other's experience, there is also little experience to use as signposts along the way.

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**A Critical Review of Nuclear Power Plant Decommissioning Planning Studies**

Energy Policy 18(5):471-479 (June 1990)

During the past decade there have been at least ten major efforts to perform comprehensive, analytical studies of the complex issues associated with decommissioning civilian nuclear power plants. These planning efforts are reviewed, using the standard framework of technology assessment. In particular, each study is analyzed to determine the degree to which formal methods of decision analysis have been employed to evaluate options and make recommendations and the degree to which formal methods of consensus have been employed to engage citizen involvement and promote public acceptance. Not unexpectedly, we find that the greatest strides in decommissioning analyses have been made in forecasting the economic costs of decommissioning to licensees. Comparatively few improvements have been made in the processes used to compare the impacts of alternative technologies more broadly or to address the legitimate concerns of interested parties more widely.

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**Closing Responsibilities: Decommissioning and the Law**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 6; (pp. 113-134) (1990)

Laws change over time and with the times. Interpretations of old laws shift and the need for new laws emerges. There are endless reasons for these necessary changes, but the basic impetus is the changing nature of societal circumstance. Fifty years ago there were no laws directly governing nuclear power in any way. Today we know that nuclear power touches people from their wallets to their descendants. Currently, many laws related to nuclear power are in place, laws that protect all sectors of society from electricity-generating bodies to a newborn child, and the Chernobyl accident has broadened the legal ramifications of nuclear power even more. This expanding body of nuclear law reflects our expanding understanding of nuclear power from its technical beginnings to its societal consequences and implications. The law is now beginning to reflect the growing significance of decommissioning. What are the relationships between decommissioning and the existing laws, government agencies, and policies? Ironically, although the United Kingdom will lead the world in addressing decommissioning responsibilities, there are no explicit laws in place to govern the process. In the absence of specific legislation governing decommissioning, the primary responsibilities fall to the operators of the power plants, a circumstance not lost on those involved in privatization. In this chapter, the wide and varied legal ramifications of decommissioning are examined.

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**Decommissioning Costs and British Nuclear Policy**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 2; (pp. 13-28) (1991)

The topic of decommissioning economics is not an isolated activity. The economics of decommissioning are linked to other, often national considerations. The advanced age of the British reactors, plus the government's desire to privatize the entire electrical utility industry, brought decommissioning to the front of public debate unexpectedly early in Britain. As decommissioning cost estimates have come under closer scrutiny, they have tended to rise from early estimates. Today, the estimated costs are much higher than in the United States. It appears that one source of higher costs will be tougher regulatory requirements. Thus, nonengineering factors are beginning to affect decommissioning costs, as they have other nuclear costs in Britain and elsewhere. It is concluded that the final costs of decommissioning are likely to be higher than original estimates.

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**Decontamination of Tools and Equipment Used for Storage and Transportation of Spent Fuel**

IAEA-TECDOC-556; CONF-8904225; Decontamination of Transport Casks and Spent Fuel Storage Facilities, Proceedings of the IAEA Technical Committee Meeting, Vienna, Austria, April 4-7, 1989, 151 pp.; (pp. 95-107) (June 1990)

This paper describes the methods and equipment used for decontamination of tools and equipment used for storage (refueling and spent fuel storage pond and revision pond) and transportation (TK6 container and C30 cask) of spent-fuel bundles at the Paks Nuclear Power Plant, Hungary. A review of contaminant characteristics and decontamination problems is given. Silver-110 is the typical contaminating radionuclide that can be strongly linked or even cemented to the contaminated surface, making removal difficult. Procedures that produce small volumes of radwaste are used because of the large surface area and volume of tools and equipment to be decontaminated. The surfaces of stainless steel equipment are decontaminated mainly by the electrochemical moving cathode procedure using acids as electrolytes or by washing with high-pressure deionized water or boric acid. Mechanical polishing methods such as the Swedish SIGMA RN1 and RM3 reactor-shaft decontamination equipment are also used. Painted surfaces in the TK6 container are cleaned using high-pressure spray heads. Use of removable films to prevent contamination of surfaces, which reduces the cost of decontamination and radwaste management, is also described.

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**The Dissolution of Magnetite and Magnetite Films on Carbon Steel Surfaces in Various Acidic Electrolytes**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (25 pp.) (June 1991)

Electrochemical experiments were performed to determine the mechanism and kinetics of the dissolution of magnetite and magnetite films on carbon steel surfaces in various acidic electrolytes. A variety of electrochemical methods were used either to control the electrode potential or simply monitor the potential adopted by the surface during the dissolution process. The dissolution processes were investigated in three distinctly different types of electrolyte: (1) a noncomplexing acid, (2) a strongly-complexing acid, and (3) a strong reducing agent. The experiments performed on the bulk magnetite electrodes demonstrated that the kinetics of magnetite dissolution are strongly potential-dependent in both complexing and noncomplexing acids. Additionally, these experiments revealed that the mechanism of magnetite dissolution is different in complexing and noncomplexing acids. Consequently, the use of decontamination reagents based on complexing rather than noncomplexing species will cause significantly faster magnetite dissolution when the magnetite exists as a particulate, a thick film, or a film on an inert metal substrate. The use of decontamination reagents based on solutions of strong reducing agents causes magnetite dissolution to occur at rates comparable to those observed in complexing acids.

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**Key Issues in the Planning for Commercial Reactor Decommissioning**

Excellent and Economic Nuclear Plant Performance, S.R. Penfield Jr. (ed.), Proceedings of the Combined ANS Power Division Topical Meeting and ASME Nuclear Energy Conference, Newport, RI, September 16-19, 1990. American Society of Mechanical Engineers, New York, NY, Vol. 4; (pp. 89-90) (1990)

The process of decommissioning a nuclear facility is quite straightforward from an execution standpoint. The physical acts of decontamination and removal of activated equipment and materials, followed by the removal of supporting systems and structures lend themselves to a very simple critical path with the opportunity for many parallel decommissioning activities involving systems and structures that are not essential to the critical path. Unfortunately, the actual process of decommissioning is the only thing about the topic that is straightforward. The process of planning for decommissioning is fraught with pitfalls. The causes include (1) the impact of the high-level waste repository debacle; (2) the impact of regional low-level waste disposal sites; (3) the impact of federal environmental regulatory control and state public utility commissions on the allowable end product of decommissioning, as well as the magnitude of allowable costs; (4) the impact of the June 1988 Nuclear Regulatory Commission regulations on the allowable level of decommissioning costs; and (5) the specific effects of these causative factors. All of these factors are discussed in this paper.

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**Working Plan of the Loviisa Nuclear Power Plant Decommissioning**

Atomnaya Energiya 67(2):83-88 (1989)

Results of the development of a decommissioning project for the Loviisa Nuclear Power Plant (NPP) (Finland), Units 1 and 2, are described. The volume of work and types of radioactive equipment and building materials to be dismantled are estimated. Variants and techniques of dismantling and underground storage are described. Doses received by personnel are evaluated, measures of radiation safety and general costs of work (for separate components, in 1987 prices) are considered. The Loviisa-1 NPP decommissioning will start in the year 2008 and the Loviisa-2 in 2012. It will take more than 12 years to realize the decommissioning procedure from Unit 1 shutdown to containment of the storage facilities and license canceling. Work to dismantle the equipment will require approximately 3000 work-years. The collective dose of irradiation for personnel involved in dismantling is assessed as 23 work-Sv. Total cost will constitute 800 million (Finnish) marks.

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**Decommissioning: A Normal Public Controversy?**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 7; (pp. 135-142) (1990)

No element of nuclear energy policy has been more damaging by its absence than an accurate appraisal of the direction or strength of public opinion. Part of the explanation for this situation is historical; there has never before been anything like nuclear power. Part of the explanation is circumstantial; never before has there been such a convergence of factors affecting society. Largely by coincidence, the great spurt in the planned use of nuclear power came at the same time as a rapid growth in energy demand, the political and physical curtailment of energy supply, the emergence of environmental awareness, and the development of public laws that facilitated the injection of organized public opinion into the decision making process. Nuclear power, while not the principal catalyst for these events, is now linked to them, and its potency increases with the public perception of the silent hazard involved and the watershed irreversibility of the decisions made. These decisions largely originate from a technical premise and a presumption of inevitable public acquiescence.

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**The Role of the United States Department of Energy in Recovering from the Three Mile Island Accident**

CONF-891108; Recovery Operation in the Event of a Nuclear Accident or Radiological Emergency, Proceedings of an International Symposium, Vienna, Austria, November 6-10, 1989. International Atomic Energy Agency, Vienna, Austria, 657 pp.; (pp. 479-493) (1990)

Even though it resulted in minimal radioactive releases to the environment, the 1979 accident at Three Mile Island Unit 2 (TMI-2) was an event with many profound impacts upon the U.S. nuclear power program. The ten year involvement of the U.S. Department of Energy and its contractors in the TMI-2 cleanup and research program has yielded many lessons of value for nuclear power programs around the world. Some of the key lessons learned were: (1) Success at TMI-2 was generally a result of innovative engineering applied to existing technology, rather than a result of the development of entirely new approaches. (2) The importance of data acquisition cannot be overstated. Through the course of the recovery, we were often tempted to bypass tedious data acquisition tasks in favor of seemingly more important "production line" work. Time and again, successful data acquisition findings proved to be the turning points that led to key program successes. (3) TMI-2 revealed that the nuclear industry needed new and improved means of collecting, concentrating, transporting and disposing of radioactive wastes generated by accidents. These improved technologies are now available for use of the nuclear community worldwide. (4) Concern for worker protection during decontamination resulted in a variety of innovations, including new surface cleaning techniques, new radiation survey equipment to quantify contamination levels, improvements in protective clothing, techniques for reducing worker heat stress, and improvements in beta dosimetry. (5) Finally, documentation mechanisms must be established and maintained so that the unique technology developed in cleanup from major nuclear accidents becomes part of the collective body of reactor safety knowledge.

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### Underwater Plasma Cutting of the Lower Core Support Assembly and Metallurgical Sample of the Bottom Head at Three Mile Island Unit 2

Nuclear Engineering 4:165-172; Nuclear Technology 87(3):648-659; Excellent and Economic Nuclear Plant Performance, S.R. Penfield Jr. (ed.), Proceedings of the Combined ANS Power Division Topical Meeting and ASME Nuclear Energy Conference, Newport, RI, September 16-19, 1990. American Society of Mechanical Engineers, New York, NY, Vol. 4; (pp. 165-172) (1990)

The lower core support assembly (LCSA) of the Three Mile Island Unit 2 reactor was not structurally damaged during the accident. To permit defueling of that region of the core, the LCSA was cut to permit access. A five-axis teleoperator was developed to deliver plasma cutting, rotary grinding, and abrasive water jetting end effectors to the LCSA. In addition, the Automated Cutting Equipment System (ACES) manipulator and plasma system were used for vertical sectioning of the baffle plates. The ACES and the end effectors were designed, fabricated, tested, and implemented in the field by PCI Energy Services. Complex geometry sectioning was completed in a mock-up facility at chemistry and pressure conditions simulating those of the vessel, prior to actual in-vessel operations. In-vessel activities began in early May of 1988 and were completed on April 11, 1989. A system was also developed for the removal of prime-shaped metallurgical specimens from the TMI-2 bottom head of the metal disintegration machining technique. Fifteen samples were taken in February, 1990. It is hoped that analysis of these samples will provide insight into the performance of reactor vessel materials under severe accident conditions.

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### Investigation of Specific Applications of Laser Cutting for Dismantling of Nuclear Power Plants

EUR-12947; 137 pp. (1990)

This work was performed on an experimental basis in a frame of strict collaboration between industry (Fiat-CIEI and Fiat-CRF in Turin) and public research laboratories [the European Nuclear Energy Agency (ENEA)-PAS-FIBI laboratories in Bologna, and the ENEA-PAS-ISP and ENEA-TIB-TECNLAS laboratories in Rome] and supported by a Commission of the European Communities contract. The aim of this work was to develop a method for better evaluation the possibilities of laser beam application in dismantling nuclear power plants. The main topics of the research have been: (1) study and definition of the relevant basic parameters ruling the aerosol generation rate and physical and chemical behavior characteristics, with the work performed in a facility specifically designed for aerosol measurements and equipped with a 2-kW(e) laser source; (2) study of the feasibility of local abatement of the aerosols produced and of the pressure drop in the high-efficiency particulate air filters; (3) study of long-distance transmission of the laser beam power performed with a 5-kW(e) laser source with an evaluation of the power loss and beam characteristic modifications; and (4) study of laser beam technique application for dismantling the Garigliano power plant steam drum to better demonstrate the feasibility of the use of this technique. The research resulted in the conclusion that the laser beam is appropriate for long-distance dismantling of metal components. Although the main aspects of the laser cutting process have been examined, some problems remain to be investigated. This examination could be performed, after proper cost-benefit evaluation, during a future decommissioning program.

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**Process and Device for Cutting Irradiated Pieces by Pressurized Water Jet**

Report; 18 pp. (May 11, 1988; November 10, 1990)

The device comprises a tank filled with water in which the piece to be cut is immersed. In the case of a cylindrical chimney, the cutting head is displaced, or the chimney turns about its axis. A positioning system keeps the chimney in front of the cutting jet. The cut particles and abrasive are reclaimed by an aspirating and filtering system.

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**Evolution of Decommissioning Methods and Technologies: Cost Optimization**

CONF-8803283; Decommissioning of Fuel Cycle Nuclear Facilities, Proceedings of a Meeting, Paris, France, March 15, 1988. Societe Francaise d'Energie Nucleaire, Paris, France, 301 pp.; (pp. 22-28) (1988)

The estimation of fuel cycle facility operation cost has become much more accurate as far as the results from latest experiments indicate. The analysis of the results allows technological development efforts to be oriented toward and progress in the direction of the reduction of operating costs, leading to a real cost optimization. In this paper, the present decommissioning methods and technologies are overviewed as regards cost optimization.

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**STMI: Several Years Experience in Nuclear Plant Dismantling**

Radioactive Waste Management, Decommissioning, and Spent Fuel Storage - Vol. 1: Waste Management Principles, Decommissioning, Dismantling, and Operations in a Hot Environment - French Industrial Experience, 389 pp.; (pp. 244-254) (October 1986)

Since 1977, when Societe des Travaux en Milieu Ionisant (STMI) performed its first dismantling operation, the company has appreciably improved in that field through important operational experience: (1) the dismantling of the calciothermy and fluoration metal plutonium preparation facility in the La Hague reprocessing plant; (2) the dismantling of the slag treatment chain associated with calciothermy and fluoration processes in the La Hague reprocessing plant; and (3) the cleaning of the EL4 cell in Marcoule. In performing these operations, the STMI operating teams attempted to improve decontamination, dismantling, handling, and transportation technologies. To increase its technical efficiency, STMI signed a cooperative agreement with Technicatome company. The union of the operational know-how of STMI and the design experience of Technicatome allows the needs of any customers facing a dismantling project to be satisfied. This report summarizes STMI's experiences and the methodologies used in dismantling the La Hague and the Marcoule facilities.

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**Decontamination and Disassembling of Waste Treatment Equipment**

Dekomisshoningu Giho 2:50-54 (June 1990)

This report presents test results derived from applying abrasive and oxy-arc cutting technologies to the disassembly of a medium-level waste liquid storage tank. Also presented are test results derived from oxy-arc and plasma arc cutting equipment used for removing a low-level waste liquid vaporizer. The instruments used for dust collection during the cutting of the waste liquid storage tank are first described, focusing on hood, spray scrubber, fabric filter, and HEPA filter. The protective devices used are then outlined. Disassembly of the medium-level waste liquid storage tank is described, focusing on the decontamination and cutting procedures. Disassembling of the low-level waste liquid vaporizer is outlined, focusing on the decontamination and cutting procedures. The report also addresses the actual performance of the dust collectors, radiation management, and waste released from the cutting of these instruments. It is stressed that instruments should be disassembled into pieces of approximately 4-6 kg and 30-50 cm for efficient decontamination. The tests revealed that oxy-arc cutting is very effective.

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**Contact-Arc Cutting and Processing in Nuclear Power**

Atomnaya Energiya 65(3):748-757 (March 3, 1989)

Contact-arc cutting and processing are considered, in which the metal is removed in the contact and arc stages of pulsed arc discharges. A scheme and techniques are described for cutting in nuclear power applications. The cutting instrument characteristics are described. Groups of equipment that are discussed include (1) disk contact-arc cutting machines; (2) devices for cutting tubes from inside, from outside, and for internal tube processing; (3) devices for boring and cutting holes; (4) mechanisms for cutting containing vessels; and (5) devices for shaping and working cavities.

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**Greenfield Decommissioning at Shippingport: Cost Management and Experience**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 9; (pp. 119-132) (1991)

Although there are many indications that nuclear power plants are likely to stay on site for a period of 60 to 100 years after closure, there are several reasons to remove the facility from the landscape, such as the desire to use the site for a new power plant or other purpose, safety, and aesthetics. Such removal is underway in several countries including Japan, the United Kingdom, and Germany. In this chapter the author looks at the internal cost management and engineering planning experience acquired during the first U.S. commercial-size plant removal, recently completed at the Shippingport Atomic Power Station near Pittsburgh. That project was especially valuable as it provided a detailed comparison between estimated and actual costs. Some of the more important findings were that (1) detailed advanced planning is cost effective, (2) labor costs can result in significant increases in total costs, (3) waste disposal costs can bring about substantial discrepancies between planned and realized costs, and (4) actual costs were within 10 percent of the estimated costs. Although there are several differences between the Shippingport reactor and other power plants, this project gave nuclear community an early opportunity to gain insights into many of the contingencies that may occur during full dismantlement.

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**Cutting Technique and System for Biological Shield**

Nuclear Technology 86:168-178; Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (10 pp.) (June 1991)

This reprint of a journal article tells that the decommissioning program of the Japan Power Demonstration Reactor (JPDR) is under way. For the purpose of dismantling the biological shield of the JPDR, a diamond sawing and coring technique and an abrasive-water jet cutting technique have been developed. In the technical development, the influence of various factors on the cutting performance and the characteristics of secondary products were investigated. As a result, remote cutting systems that incorporated these techniques were fabricated for the dismantlement of the highly activated region of the biological shield.

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V.M. Nazarov, M.V. Frontas'eva, P.A. Lavdanskij, and N.I. Stefanov, Joint Institute for Nuclear Research, Dubna, USSR; Moskovskij Inzhenerno-Stroitel'nyj Institute, Moscow, USSR

**Application of Activation Analysis to Solving the Problems of Radiation Protection Design of Nuclear Reactors in View of Their Decommissioning**

JINR-D-14-88-833; CONF-8806507; Modern Trends in Activation Analysis in JINR, Proceedings of an International Workshop, Dubna, USSR, June 26-28, 1988, 206 pp.; (pp. 114-122) (1988)

Experimental investigation of radionuclide composition of long-lived induced activity (LIA) in building materials (in particular, concrete used as shielding material for reactors) was conducted by neutron activation analysis using the IBR-2 reactor. Flux density of thermal, resonance, and fast neutrons in the channel constituted 1.1 X 10(E+12), 0.23 X 10(E+12), and 1.4 X 10(E+12) n per cm(E-2)/s(E-1), respectively. Sc-46, Co-60, Cs-134, Eu-152, Eu-154, and Ta-182 are the main radionuclides that cause LIA for all building materials except quartz sand. The content of chemical elements in building materials on which isotopes of the mentioned nuclides are formed is within the limits of n X 10(E-2) to n X 10(E-6)%. The information obtained from this investigation will allow development of and recommend new design solutions for radiation protection during the reactor dismantling process.

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K. Neset, G.C. Christensen, J.E. Lundby, and G.A. Roenneberg, Institutt for Energiteknikk, Kjeller, Norway

**The Decommissioning of a Small Nuclear Reactor**

IFE/KR/E-90/001; 54 pp. (February 1990)

The JEEP II reactor at Kjeller, Norway has been used as a model for a study of the decommissioning of a small research reactor. A radiological survey is given, and a plan for volume reducing, packaging, certifying, classifying, and shipping of the radioactive waste is described.

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**Nuclear Decommissioning**

International Power Generation 14(1):42-43 (January 1991)

Decommissioning a nuclear power station or other facility is a relatively new and highly complex industry requiring extremely high levels of safety, specialized knowledge and equipment. AEA Technology in the United Kingdom claims to be the most experienced and technically capable company in this field in the world. This report reviews their experience, which includes the decommissioning to date of 15 reactors of various types and 35 other nuclear facilities and expertise in remote handling and treating radioactive waste.

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T. Onuma, H. Akimoto, N. Shikata, and H.

Miura, Hitachi Plant Engineering and Construction Company Limited, Tokyo, Japan

**Decontaminating Method and Device for Radioactive Metal Waste**

Japanese Patent JP 2-99899/A; 5 pp. (April 11, 1990)

The present invention concerns decontamination of radioactive metal wastes contaminated at their surface and released from radioactive material handling facilities such as nuclear power plants. Ultrasonic wave vibrators are disposed at the bottom and on the side of a decontaminating vessel. Among the radioactive metal wastes, carbon steel series wastes are simply immersed in the decontaminating vessel, while stainless steel series wastes are electrolytically reduced at the initial stage of immersion. In this case, cladding materials containing most of the radioactive materials are peeled off accompanying the melting of the matrix metals. For improving the pe ling effect, ultrasonic waves are applied over a predetermined period of time by the ultrasonic wave vibrators just before pulling up the radioactive metal wastes. Thus, decontaminating treatment for the radioactive metal wastes can be conducted to such a radioactive level as that for ordinary wastes without using oxidative metal salts and at a high efficiency.

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T. Onuma, and A. Hidetoshi, Hitachi Plant Engineering and Construction Company Limited, Tokyo, Japan

**Chemical Decontamination of Stainless Steel**

K/TR 91/1; Japanese Kokai Patent HEI 2[1990]-22596; 17 pp. (1990)

The patent is for a method of chemical decontamination of stainless steel comprised of (1) immersing a stainless steel-based metal waste material, contaminated by radioactive materials on the surface, in a sulfuric acid solution and (2) immersing the metal waste material in an aqueous solution of sulfuric acid and metal-oxidizing salt. A portion of the surface of the stainless steel is polished mechanically to expose the base material before the above processes take place. By polishing a portion of the contaminated material first, the exposed stainless steel base material is chemically dissolved in the sulfuric acid solution. By the local cell reaction described in the patent, the remaining passivation film is dissolved, then base material is again dissolved, and the dissolution reaction spreads to the entire surface of the contaminated material. The method is easily applied to the decontamination of even complex-shaped materials.

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T. Onuma, A. Tanaka, and H. Akimoto, Hitachi Plant Engineering and Construction Company Limited, Tokyo, Japan

**Method of Decontaminating Radioactive Metal Waste**

Japanese Patent 1-138497/A; 5 pp. (May 31, 1989)

In the decontamination of radioactive metal wastes, a method of using electrolytic polishing decontamination and chemical decontamination together and re-using the spent solution in the chemical decontamination process as an electrolytic solution in the electrolytic polishing decontamination process has been proposed. However, reduction in the efficiency of the electrolytic polishing decontamination causes a problem in this method. In the present invention, spent, neutralized solution from the chemical decontamination process is used as the electrolytic solution after removing permanganate ions (MnO-4) therein. According to the present method, there is no reduction in the decontaminating performance and the radioactive metal wastes can effectively be decontaminated down to radioactive levels of ordinary wastes.

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S. Openshaw, University of Newcastle, Newcastle, United Kingdom

**Nuclear Archaeology: The Influence of Decommissioning on Future Reactor Siting in the UK**

Nuclear Decommissioning and Society, M.J.

Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 8; (pp. 143-158) (1990)

Whereas considerations of waste, cost, opinion, and the law are often abstract elements of nuclear power, the siting of generating stations produces concrete land use and aesthetic reminders of its presence. What will future generations find as a result of the nuclear era? Will the power plant sites be restored to greenfield conditions? When will this occur? How will such decisions affect surrounding land use and societal characteristics such as employment opportunities and quality of life? These and other questions revolve around the land use and siting links to decommissioning decisions. The two prime determinants of the land use legacy will be the timing of stage 3 dismantlement and the degree to which the sites can be restored to preuse conditions. In this chapter it is argued that the sites are unlikely ever to be released for unrestricted use, but rather that the use and the visual impacts of the sites will increase over time, eventually becoming the objects which, perhaps, future archaeologists will study.

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S. Owens and D. Cope, University of Cambridge, Cambridge, United Kingdom; United Kingdom Centre for Economic and Environmental Development, London, United Kingdom

**The Wider Perspective of Decommissioning**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 11; (pp. 186-202) (1990)

As we come upon the time of a "full earth," we must think more about the consequences of our various economic ventures, especially when these consequences are far away or long-term. We have come to realize the importance of this approach as we have expanded our use of nuclear power, but it is applicable as well with all manner of derelict nonnuclear facilities. Decommissioning, then, is a generic issue. The earliest focus of decommissioning attention rightly stresses nuclear power plants because of the hazards, scale, expense, and public connection, but this focus must also be wide enough to encompass nonnuclear facilities such as conventional power plants, offshore drilling platforms, disused mines, and all manner and variety of other remnants as well. Although radioactivity sets nuclear installations apart from all others, nonradioactive equipment nevertheless burdens the landscape. This may not be seen to be as important in a large country such as the United States, but in smaller countries such as the United Kingdom all resources must be husbanded wisely and this includes the safe sequential use of its land and offshore resources. Such considerations are common with all types of resource development and lead us quite naturally to the growing need for "life-cycle" planning in all our endeavors.

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N.H. Packan, R.E. Stoller, and A.S. Kumar, Oak Ridge National Laboratory, Oak Ridge, TN

**Investigation of Materials from a Decommissioned Reactor Pressure Vessel**

CONF-880613; Effects of Radiation on Materials, Proceedings of the 14th International Symposium, Andover, MD, June 27-29, 1988, 820 pp.; (pp. 80-106) (1990)

This paper reports on material samples from the reactor pressure vessel of a decommissioned nuclear power plant (Gundremmingen Unit A), located in the Federal Republic of Germany (FRG). The materials were trepanned and investigated in the FRG within an international cooperative program to establish material toughness data for comparison with those obtained from the surveillance program and the initial material state. The material under consideration is base material from the circumferential weld and heat-affected zone of several vessel shells. The available data on this material include acceptance data, irradiated state data, and data obtained from the thermally-aged-only condition. The fluence of the vessel wall was in the range of 3-4 X 10/E. The material response to neutron radiation is compared with the code trend curves. For the material of one vessel shell, severe degradation (an upper-shelf drop down to 55 J) was found in the transverse direction, which is not in accordance with the existing trend curves.

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M.J. Pasqualetti, Arizona State University, Department of Geography, Tempe, AZ

**Public Links to a New Technology**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 1; (pp. 3-13) (1990)

Failure to perceive the public links of nuclear power has plagued nuclear power development almost from the beginning of its civilian use, starting with worries about operational safety, continuing with concerns about waste disposal, and reaching most recently to the shortcomings of emergency preparedness and operator training. All these unnoticed connections surfaced during the experience of operating nuclear power plants over the past three decades, but things are beginning to take on a new dimension; the implications of these original oversights have now reached the last phase in the life of a nuclear power plant decommissioning. As decommissioning attracts more public attention, the troubling reality that we are repeating the established patterns is apparent; trust in technology is dominating research and preparations. This time, however, with the experience of the recent past fresh in our minds, we may be better able to identify and anticipate what this new step could mean to all of us. Ideally, this would facilitate more meaningful public contribution to planning already under way.

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M.J. Pasqualetti, Arizona State University, Department of Geography, Tempe, AZ

**Of Links and Legacies**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 12; (pp. 203-208) (1990)

This book addresses the public links to decommissioning. Particular attention is paid to how public involvement in the discussions about decommissioning currently under way will affect decommissioning policy. In turn, some of the impacts that decommissioning decisions will have on the public have also been discussed. This chapter summarizes some of these we have discovered and asks where this information will take us.

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M.J. Pasqualetti, Arizona State University, Department of Geography, Tempe, AZ

**Decommissioning from Ground Level: Sizewell and the Uncertainties of Faith**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 2; (pp. 14-37) (1990)

The Sizewell B Inquiry was the longest, most complete, and most expensive public evaluation of civilian nuclear power ever undertaken. Even though it was originally set up to address a proposal to build the first pressurized water reactor in the United Kingdom, the wide-ranging information and conclusions it produced warranted consideration in the context of virtually any aspect of nuclear power. It was while reviewing the Sizewell transcript on the subject of decommissioning that many uncertainties were uncovered and found to have common characteristics wherever decommissioning takes place. It was this observation, particularly in the context of the social links to the actual technical tasks and decisions, which served as the catalyst for this book.

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M.J. Pasqualetti, Arizona State University, Department of Geography, Tempe, AZ

**The Place of Economics in Decommissioning Policy**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 1; (pp. 3-12) (1991)

Commercial nuclear power development has reached the point in its life cycle when older power plants must now be prepared for removal from service. The decision to decommission a nuclear facility is based mostly on obsolescence, and there are essentially three types of obsolescence: regulatory, economic, and technological. Regulatory obsolescence derives from an inability to continue operating in compliance with changed regulations. Economic obsolescence can be caused either by aging of equipment and components to the extent that maintenance, repair and replacement costs are too high to permit continued economic operation, or by the unavailability of replacement parts which necessitate expensive large- scale renovation. Technological obsolescence can be caused by progress leading to either a more efficient or a more economical alternative production method. The root cause for abandonment, even for the three types of obsolescence just mentioned, is economic in nature, and the clearest single indicator of such economic uncompetitiveness is station age. Naturally, the age factor is most apparent in countries with the oldest reactors, such as the United States. This article discusses the wide range of economic considerations likely to become important as more facilities are decommissioned, including legal requirements and restrictions, environmental concerns, risk assessment, cost estimates, and public funding of decommissioning operations.

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M.J. Pasqualetti (ed.), Arizona State University, Department of Geography, Tempe, AZ

**Nuclear Decommissioning and Society: Public Links to a New Technology**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp. (1990)

Links between decommissioning in general, reactor decommissioning in particular, and the public are indexed. The established links are recognized and others, such as jobs, are discussed. Finally the links with policy, such as political geography, and wider issues of the environment and public concern over waste disposal are considered. Decommissioning is a relatively new field where public opinion must now be considered but it has implications both for existing nuclear power plants and those planned for the future, especially in their siting. This book looks especially at the situation in the United Kingdom. There are twelve papers, all indexed separately.

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M.J. Pasqualetti and G.S. Rothwell (eds.), Arizona State University, Department of Geography, Tempe, AZ; Stanford University, Stanford, CA

**Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties**

The Energy Journal 12: Special Issue. Energy Economics Educational Foundation, Washington, DC, 346 pp. (1991)

This special issue of The Energy Journal is the first attempt to bring together in a single volume the fundamentals of nuclear decommissioning economics. The purpose of the volume is to make a broad range of material widely available to enhance the chances for informed public discussion and decision, especially in the contexts of funding adequacy, contingency factors, the timing of dismantlement, and the effects of premature closure and extended life. There are 24 articles by 33 experts divided among the following chapters: (1) Economics and Policy, (2) Regulatory Responsibilities in the U.S., (3) Learning from Experience, (4) Alternative Approaches to Decommissioning Estimates, (5) Trust Fund Management and Investment, (6) Remaining Uncertainties, and (7) Applying the Experience. A wide range of subtopics related to decommissioning economics is addressed including costs, cost estimation, the risk of undercollection, what experience tells us so far, the U.S. regulatory atmosphere, approaches to decommissioning outside the U.S., public utilities' attitudes toward decommissioning costs, the connection of cost to waste, extension of plant life, the timing of dismantlement, investment of funds, the effect of decommissioning on nuclear power policy, and where the present concentration on decommissioning will lead with regard to other facilities such as coal plants. Individual papers in this special issue are listed separately.

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F. Passant, Nuclear Electric, Barnwood, United Kingdom

**Radical Approaches Could Reduce the Liability for UK Decommissioning**

CONF-9006301; Nuclear Power in a Changing World, Proceeding of the British Nuclear Forum Conference, London, United Kingdom, June 25-27, 1990; (2 pp.); Nuclear Engineering International 35(434):25-26 (September 1990)

The objectives of decommissioning a nuclear power station are (1) to ensure the continued safety of the public, the workforce, and the environment; (2) to minimize the environmental and visual impact of the station; to release land for other use; and (3) consistent with the above, to minimize the expenditure of national resources on decommissioning. Alternative approaches to the accepted United Kingdom reference strategy could considerably reduce the cost of decommissioning. Currently the reference strategy is based on dismantling to a "green field" site in three stages. Two alternative options are outlined. The first involves limited dismantling followed by the building of a substantial containment around the remaining reactors and plant; complete dismantling is deferred till the restoration to a green field site in stage three. The second option involves mounding over and landscaping the entire plant in situ. It is agreed that large savings and much lower than acceptable radiological risks to the public can be achieved through these options.

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P. Pattantyus, Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, Canada

**Decommissioning of NPD from an AECL Perspective**

INIS-mf-12827; CONF-880662; Proceedings of the 28th Annual Conference of the Canadian Nuclear Association and the Ninth Annual Conference of the Canadian Nuclear Society, Winnipeg, Canada, June 12-15, 1988, 488 pp.; (pp. 197-201) (1988)

In 1987 it was decided to decommission the Nuclear Power Demonstration generating station at Rolphton, Ontario when it was revealed that the pressure tubes had deteriorated to the point where further operation of the station was deemed unacceptable. Atomic Energy of Canada Limited (AECL) owns the reactor and associated nuclear systems, while Ontario Hydro owns the site, aboveground structures, and conventional plant equipment. Ontario Hydro has been operating the station. While Ontario Hydro has taken responsibility for final operation of the plant, AECL has been looking after the transport and storage of irradiated fuel, heavy water, and operational radioactive waste to storage facilities at Chalk River Nuclear Laboratories and has been preparing a static state definition license application to the Atomic Energy Control Board. As of September 1988, AECL will assume responsibility for site security and remote surveillance. In 1989, Ontario Hydro construction staff will carry out dismantling work as defined by AECL.

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O. Pavlik, Hungaria Academy of Sciences, Institute of Isotopes, Budapest, Hungary

**Electrochemical Decontamination for the Main Pipeline of the Primary Circuit by Movable Cathode**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (15 pp.) (June 1991)

Contamination of the primary circuit of water-cooled reactors is essentially governed by the behavior of iron, chromium, nickel, and cobalt isotopes in the coolant. Since cations can easily build up on the metallic surfaces in the primary circuit, the decontamination can only be carried out by the removal of the upper layer of the deposits containing the above-mentioned radioactive isotopes. An effective decontamination procedure removes most of the contamination without excessive corrosion of the substrate. Electrochemical decontamination is the reverse procedure of electroplating. The upper oxide layers containing contaminants can be removed from the metal surface using a direct electric current between the workpiece and a cathode in an electrolyte. The method can be applied by immersing the workpiece to be decontaminated in an electrolyte tank as an anode. During the last few years, a special electrochemical procedure was developed for the decontamination of large or immobile equipment using movable cathodes. Three electrochemical, remotely-operated decontamination devices have been developed in Hungary at the Paks Nuclear Power Plant. Considering the good decontamination results achieved by these devices, the development of the electrochemical method has been extended for the decontamination of the main pipeline in the primary circuit at Paks. A weak acidic electrolyte was developed on the basis of laboratory experiments. Using this electrolyte, the achievable decontamination factor was relatively high (20-500) and the corrosion rate was low. A crawler was developed as a carrier of testing and decontamination devices and tested in horizontal, vertical, and apple pipes. On the basis of these tests, some modifications will be carried out.

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K. Pflugrad, Commission of the European Communities, Brussels, Belgium

### The European Communities' R&D Programme in the Field of Decommissioning of Nuclear Installations

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (4 pp.) (August 1991)

Many of Europe's first experimental reactors, nuclear power plants, and fuel cycle facilities built in the 1950s are no longer in service. As the turn of the century approaches, more and larger nuclear plants will come to the end of their useful lives. To promote a safe and orderly dismantling of the obsolete facilities, the European Community has, since 1979, been carrying out 5-year research and development (R&D) programs on decommissioning of nuclear installations. The current program, which is the third of its kind, will be concluded at the end of 1993. These programs are mainly implemented by means of shared-cost contracts with research organizations and firms in the member states. Under these contracts, the European Community funds up to 50% of the cost of a research project. The three main categories of R&D pursued under the present program are (1) technical assessment and development studies, (2) identification of guiding principles and (3) field testing of new techniques. Progress and results of the research carried out under contract are reported regularly. The program management publishes annual progress reports, conference proceedings, and the final reports of each R&D contract in a special series. A list of publications can be obtained upon written request.

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K. Pflugrad, Commission of the European Communities, Brussels, Belgium

### Programme on the Decommissioning of Nuclear Installations: List of Publications

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (9 pp.) (August 1991)

This document contains a list of publications created by the Commission of the European Communities' Research Programme on the Decommissioning of Nuclear Installations. Included in the list are the following publications: (1) Official Journal of the European Communities, (2) annual program progress reports, (3) final contract reports, and (4) conference papers and proceedings. The final contract reports are divided into three categories: (a) preliminary studies, (b) 1979-83 program on decommissioning of nuclear power plants, and (c) 1984-89 program on decommissioning of nuclear installations.

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G. Pilot and C. Morillon, Commission of the European Communities, Luxembourg; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France

**Decontamination of Concrete by Superficial Melting with a New Burner Associated to a Plasma: Feasibility Study**

EUR-12489; 58 pp. (1989)

This experimental study shows methods by which a concrete wall impregnated with Cs-137 can be decontaminated. The configuration of plasma and propane combustion is the more promising solution compared to a plasma-air configuration. Advantages of plasma-propane combustion include a low-level of nitrogen oxides (20 to 40 ppm for the plasma-propane configuration and 1700 ppm for the plasma-air configuration) and better thermal efficiency of the jet impact. Results are analyzed and technological possibilities are evaluated.

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M.J. Plews, A.R. Davies, and G.J. Butterworth, Electrowatt Engineering Services Limited, Horsham, Sussex, United Kingdom; Euratom/United Kingdom Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, United Kingdom

**The Cost Benefit Analysis of Recycling Low Activity Steels from Fusion Reactors**

CLM-R296; 334 pp. (August 1989)

A study has been performed to analyze and compare the costs, occupational and public radiation doses, and the benefits associated with alternative routes for the management of fusion reactor structural wastes. These routes comprise permanent disposal and recycling after a period of storage. The two alternative waste management routes are defined, and the plant and equipment requirements for initial processing, storage, packaging, transport, disposal, remelting, conversion and fabrication, and reassembly are set out. Costings take account of the capital costs of plant, equipment, and raw materials as well as operating, maintenance, and labor costs. Occupational radiation exposures are calculated for normal operation and maintenance tasks from estimates of staffing levels and area dose rates. Doses to members of the public are calculated for exposure to direct radiation, airborne releases, and liquid effluent releases, and the risks from post-disposal intrusion are estimated. While it is recognized that aspects of the radionuclide inventory data are still uncertain and that this might influence waste management strategies, a number of conclusions can be drawn from the study. The slightly lower costs and the lower occupational doses and short-term public doses associated with the direct disposal of steels suggest that this may be the preferred waste management route, but other factors that are more difficult to quantify would make recycling more favorable. These include an increase in the future costs of steel, the potential for lower impurity levels in low activation steel, improvements in steel-remelting technology, the public attitude to radioactive waste disposal, and a perceived material-resource problem in the future.

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N. Ponnampalam

**The Decommissioning of Scamp**

Atomic Weapons Establishment News 37(7):22-23 (July-August 1990)

This paper looks at the United Kingdom's Atomic Weapons Research Establishment's (AWRE) 20-year project on decommissioning of redundant plutonium facilities. AWRE's phased approach to decommissioning ensures that the redundant plant remains safe until its disassembly can be started. The phases include preparation, care and surveillance, decommissioning, building care and maintenance, and building demolition. Particular detail is offered on the decommissioning of the Solution Criticality Assembly Machine Plutonium (SCAMP) rig.

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International Relations, Buenos Aires, Argentina

**Disassembly of the RA3 Reactor**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (9 pp.) (August 1991)

This record deals with the organization of the RA3 reactor disassembly project, and the transport and storage of different reactor components. The reactor is a pool-type reactor, moderated with light water and reflected by graphite. It has a material-testing reactor-type fuel element enriched 90% by U-235, with 5 MW(t) power, and operated normally for 20 years. The enrichment of the reactor had to be modified in 1987 from 90% U-235 to 20% U-235. In 1988, work on the adaption of the core started; the work consisted of total disassembly of the core and transportation and storage of the different reactor elements. This work was performed by three teams, composed primarily of the operation, maintenance and radioprotection personnel, with the help of the quality assurance group.

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A.Z. Pusztai, Wisconsin Electric Power Company, Milwaukee, WI

**NRC Rule on Decommissioning**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 349-354) (1988)

This paper discusses the final rule by the Nuclear Regulatory Commission on decommissioning. It will address requirements and options available for decommissioning of nuclear facilities. During the past ten years, there has been much controversy and concern about decommissioning, specifically, estimated costs, waste disposal, funding, and safety; despite these important considerations, the nuclear industry appears slow in considering the role of Quality Assurance (QA). QA must be an integral part of decommissioning to ensure that activities are properly performed and managed. At present, the industry has no consensus national standards addressing the unique problems posed by decommissioning. With prudency hearings so widespread today, nuclear utilities can expect close scrutiny of their decision to decommission, their decommissioning plans, and their implementation of these plans.

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**Regulations by the DFTCE Concerning the Fund for the Decommissioning of Nuclear Installations**

INIS-XN-277; 21 pp. (February 1985)

These regulations were made by the Swiss Federal Ministry of Transport, Communications and Energy in implementation of the Ordinance of December 5, 1983 establishing a fund for the decommissioning of nuclear installations. They specify the way in which nuclear operators must contribute to the fund and the method for calculating the contributions. The costs of decommissioning also include dismantling and disposal of the resulting waste. The regulations entered into force retroactively, on January 1, 1984, on the same date as the 1983 Ordinance.

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T. Riordan, University of East Anglia, United Kingdom

**Decommissioning and Nuclear Energy Policy in the UK**

Nuclear Decommissioning and Society, M.J. Pasquelletti (ed.), Routledge, London, United Kingdom, 254 pp., Ch. 10; (pp. 174-185) (1990)

Current nuclear energy policy in the United Kingdom is derived from the physical vulnerabilities of an island nation and from the anticipated decline of North Sea reserves, coupled with environmental concerns and the political instabilities of foreign oil and domestic coal supplies. The essence of the present nuclear energy policy is to offset the vagaries of traditional supply by increasing the use of fuel, which provides firmer government control. This paper explores how government and industry are approaching the decommissioning task. It explores why decommissioning, which is so closely connected with the highly controversial issue of radioactive waste disposal, is not seen as a major economic burden on the building of nuclear power plants. No longer is the private sector regarding such costs with equanimity as they prepare to invest in the United Kingdom's aging nuclear stock. At Sizewell, decommissioning received only passing attention, and this low level of interest reflects a tacit position that decommissioning is of only minor significance in British nuclear energy policy. However, given the rising public interest in decommissioning - most recently witnessed at the Hinkley Point Inquiry - and in light of the more detailed studies of the implications of decommissioning, the new economics of the back end of the nuclear fuel cycle have made moribund the British nuclear industry as it is currently constituted.

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W.M. Ross, Her Majesty's Nuclear Installations Inspectorate, Bootle, United Kingdom

**Regulatory Aspects of Nuclear Reactor Decommissioning**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 164-174) (April 1990)

This paper discusses the regulatory aspects of decommissioning commercial nuclear power stations in the United Kingdom. The way in which the relevant legislation has been used for the first time in dealing with the early stages of decommissioning commercial nuclear reactors is described. International requirements and how they fit in with the United Kingdom system are covered. The discussion focuses on the changes which have been required, under the Nuclear Site License, to ensure that the licensee carries out the work of reactor decommissioning in a safe and controlled manner.

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G.S. Rothwell, Stanford University, Department of Economics, Stanford, CA

**The Optimal Time to Decommission Commercial Nuclear Reactors**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 24; (pp. 305-314) (1991)

One of the key questions related to decommissioning is its optimal timing. This chapter presents a mathematical model developed to answer this question. The real cost of decommissioning a reactor is specified as a function of its size, the volume of radioactive material, radiation exposure regulation, and the rate of productivity change in the decommissioning industry. The model allows calculation of an optimal waiting period between reactor shutdown and decommissioning. The optimal waiting period decreases with stricter radiation exposure regulation and higher inflation rates for radioactive waste disposal.

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R. Rouviere, M. Pinault, B. Gasc, R. Guiadeur, and M. Pilot, Commission of the European Communities, Luxembourg; Commissariat a l'Energie Atomique, Etablissement de la Vallee du Rhone, Bagnols-sur-Ceze, France; Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France; Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France

**Adaptation of High Pressure Water Jets with Abrasives for Nuclear Installations Dismantling**

EUR-12490; 95 pp. (1989)

This report describes efforts to adapt cutting technology, which uses high-pressure water jets with abrasives, to the task of dismantling nuclear facilities. The work required the design and modification of a remote tool. Cutting tests and waste-product analyses were performed. This technique can be improved by the development of better remote-viewing systems and better particulate-suction systems.

284
S.B. Russell, Ontario Hydro, Toronto, Ontario, Canada

**Preliminary Dose Assessment of On-Site Burial of Decommissioning Waste**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 487-490) (1986)

This paper presents an evaluation of the potential radiation dose from an alternative being considered for managing of decommissioning wastes, the on-site burial of four reactor units in underground pits beneath the reactors at the Bruce Nuclear Generating Station A. The reactor and other contaminated components were assumed to leach radioactive contamination into the groundwater, which then discharged into Lake Huron and was subsequently used by a farmer who grew all his own food. The maximum individual dose rate was conservatively calculated to be about 3 mrem/yr. Consequently, the on-site burial of reactor components was judged to be a viable management option for decommissioning wastes.

285
M. Sappok, Siempelkamp Giesserei GmbH and Company, Krefeld, Federal Republic of Germany

**Results of Melting Large Quantities of Radioactive Steel Scrap**

Nuclear Technology 86:188-191 (August 1989)

A method is developed for treating contaminated, low-level radioactive metallic waste from nuclear facilities by melting. The goal is to reduce the volume of scrap to be stored in the final depository because of the high costs of storage. It is possible to recycle the material by using it to produce components to be used in other nuclear facilities, especially for shielding purposes. Products include shielding blocks, shielding doors, and type A and B containers used for transport and storage of radioactive waste. This method had to meet safety requirements to be licensed by the appropriate authorities. The license was granted in 1985, and about 1500 tons of material has been processed.

286
V.A. Savchenko and V.M. Tarasov

**Main Principles for the Loviisa Plant (Finland) Decommissioning**

Ehnergeticheskoe Stroitel'stvo za Rubezhom (Supplement to Ehnergeticheskoe Stroitel'stvo):15-17 (April 1989)

Decommissioning projects of the Loviisa Nuclear Power Plant (NPP), planned for the year 2008 are considered. Dismantling and shipment of assemblies are supposed to be performed in large units (steam generators, pressure compensators, and reactor vessel) without cutting them into minor elements. The reactor vessel will be used as a package for the more radioactive elements. Prior to transportation to the storage area, which is to be constructed in a rock massif at a depth of 100 m, the vessel will be placed in a 300-mm thick concrete coating. This work is expected to take 12 years and 4 months to complete. A variant with a 30-year postponement of dismantling after the reactor shutdown was analyzed; this longer time period would allow a significant decrease in equipment radioactivity. However, calculations have shown that in this case financial expenses and material requirements for conservation and servicing of the shutdown NPP would be high.

287
M. Schrauben, ONDRAF, Brussels, Belgium

**Project Planning and Management for the Decommissioning of Research Reactors**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (17 pp.) (August 1991)

This report deals with the Belgian experience in the field of reactor decommissioning. Relevant legal and constitutional constraints, as well as the organization of the decommissioning process, are discussed. The form and contents of decommissioning plans are reviewed. Finally, decommissioning projects currently under way are particularized.

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A.E. Sheil and A.P. Colquhoun, British Nuclear Fuels Limited, Sellafield, Seascale, Cumbria, United Kingdom

**Environmental Protection Considerations During Decommissioning**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 497-502) (1990)

The British Nuclear Fuels Limited (BNFL) Sellafield site has been involved with the United Kingdom nuclear program since its inception. Consequently, the company is now faced with a major decommissioning challenge which is being met by a rolling 10-year program of decommissioning. The site has industrial scale plants reflecting the whole nuclear cycle from reactors through reprocessing to fuel manufacture with all associated waste facilities, etc. BNFL is committed to decommissioning all these facilities within a fixed period from cessation of operations. The paper reviews this program, outlines project organization and management, and discusses the constraints imposed by the United Kingdom waste disposal situation. Decommissioning involves decontamination, dismantling, and demolition, all of which generate mobile radioactive material with potential to escape to the environment. Liquid and aerial effluents and solid residues all require that attention be paid to containment and environmental protection. The basic principle adhered to by BNFL in these operations is to contain activity and immobilize it as close to the source as practical. The application of this concept is illustrated by examples from two very different projects: (1) a Mixed Oxide Fuel Fabrication Plant and (2) the 400-ft high Windscale Pile Chimneys.

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A.E. Sheil and R.F. Matthews, British Nuclear Fuels Limited, Sellafield, Seascale, Cumbria, United Kingdom; W.S. Atkins and Partners, United Kingdom

**Planning and Management of Stage 1 Dismantling of B16 Pile Chimney, Sellafield**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 147-155) (April 1990)

This paper describes the planning and execution of the decommissioning and dismantling of the top sections of one of the two Pile Chimneys at Sellafield. It describes the complex structure of the Chimneys and their history and original function and summarizes the investigations into the condition of the Chimneys, which led to the decision to decommission. Specific mention is made of the approach to safety, both radiological and industrial. This includes preparation of safety cases, environmental protection methods, detailed method statements for the work, and safety equipment used. It also explains the management structure and contractual arrangements used to control both safety and costs. The paper then describes six specific phases of work and how each is carried out. The phases of the work are (1) preparatory work of removing redundant equipment and provision of access to the Chimney top, (2) removal of glass fiber insulation from the cavity above the filters at the Chimney top, (3) protection measures to surrounding plant and buildings, (4) erection of scaffolding around the head of the Chimney and installation of working platforms within the Chimney flue, (5) removal of the aluminum lining from above the filters and the Chimney cap plates, and (6) removal of brickwork and structural steel frame of the Upper and Concentrator Sections.

**290**

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**Technology, Safety and Costs of Decommissioning Reference Non-Fuel-Cycle Nuclear Facilities: Compendium of Current Information**

NUREG/CR-1754 (Add. 1); 221 pp. (October 1989)

Cost and safety information is developed for the conceptual decommissioning of nonfuel-cycle nuclear facilities that represent a significant decommissioning task in terms of decontamination and/or disposal activities. Reference facilities examined in this study include six types of laboratories and three site elements associated with materials facilities that require some decommissioning effort. Decommissioning of these reference facilities and sites can be accomplished using techniques and equipment that are in common industrial use. Since decommissioning technology for nonfuel-cycle nuclear facilities has not changed appreciably since publication of NUREG/CR-1754, essentially the same technology assumed in that study is used in this study. For the reference laboratory-type facilities, the study approach is to first evaluate decommissioning of representative components (e.g., hoods, glove boxes, building surfaces, exhaust system ductwork, etc.) that are common to many laboratory facilities. Reference laboratories are then analyzed using data for individual components (the unit-component approach) to provide information about the costs and safety of decommissioning entire facilities. DECON is the decommissioning alternative evaluated for the reference laboratories because it results in release of the facility for unrestricted use as soon as possible. In decontaminating a facility, DECON requires that contaminated components either be (1) decontaminated to unrestricted release levels, or (2) packaged and shipped to an authorized disposal site.

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E.Y. Shum and S.M. Neuder, U.S. Nuclear Regulatory Commission, Washington, DC; Pacific Northwest Laboratory, Richland, WA

**Decommissioning of Nuclear Facilities Involving Operations with Uranium and Thorium**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 141-146) (1990)

When a licensed nuclear facility ceases operation, the U.S. Nuclear Regulatory Commission (NRC) ensures that the facility and its site are decontaminated to acceptable levels so they may be safely released for unrestricted public use. Because specific environmental standards or broad federal guidelines governing release of residual radioactive contamination have not been issued, NRC has developed ad hoc cleanup criteria for decommissioning nuclear facilities that involved uranium and thorium. Cleanup criteria include decontamination of buildings, equipment, and land. This report addresses: (1) cleanup criteria and their rationale; (2) procedures for decommissioning uranium/thorium facilities; (3) radiological survey designs and procedures; (4) radiological monitoring and measurement; and (5) cost-effectiveness to demonstrate compliance.

**292**

H. Sigl, Bayernwerk AG, Muenchen, Federal Republic of Germany

**Dismantling of Nuclear Power Plants**

Elektrizitaetswirtschaft 89(19):1026-1028 (September 10 1990)

In the Federal Republic of Germany, decommissioned nuclear power plants have to be dismantled. This obligation has to be taken into account in the price for electricity, in the annual balance sheet, and in terms of liquidity. This requirement presents considerable forecast problems. The monetary reserves for fulfilling and financing the decommissioning obligation accumulate over 19 years at the price of the appropriate allocation year. The mode of cost accounting and balancing of reserves, however, fulfills the main requirements: (1) just and periodic passing on of dismantling costs to the electricity price and (2) sufficient liquid funds for appropriate decommissioning and dismantling tasks.

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### Development of Dismantling Technology for Spent Melter

CONF-891006 (Vol. 2); Waste Management - High Level Radioactive Waste and Spent Fuel Management, Proceedings of the 1989 Joint International Conference, Kyoto, Japan, October 22-28, 1989, Vol. 2, 618 pp.; (pp. 261-264) (1989)

The authors' company plans to employ the joule-heated ceramic melter in the Tokai vitrification facility (TVF). In the plant operation, the lifetime of the ceramic melter is estimated to be about 5 years because of the corrosion of its component materials by molten glass. This ceramic melter becomes large-size solid waste with high radioactivity after its lifetime. The authors' company has been developing the dismantling technology for the ceramic melter since 1984. Technology development described in this paper includes a cutting technique of the metallic casing and the refractories, a dismantling test for the mock-up melter using a remotely operated power-manipulator, in-cell cranes, and various tools. The mock-up tests using Power Reactor and Nuclear Fuel Development Corporation-selected systems proved their satisfactory performance for use on spent melter dismantling.

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R.I. Smith, Pacific Northwest Laboratory, Richland, WA

### Approaches to Estimating Decommissioning Costs

PNL-SA-18160; CONF-9006264; Proceedings of the 65th Annual International Western Economic Association Conference, San Diego, CA, June 29-July 3, 1990; (13 pp.) (July 1990)

The chronological development of methodology for estimating the cost of nuclear reactor power station decommissioning is traced from the mid 1970s through 1990. Three techniques for developing decommissioning cost estimates are described. The two viable techniques are compared by examining estimates developed for the same nuclear power station using both methods. The comparison shows that the differences between the estimates are due largely to differing assumptions regarding the size of the utility and operating contractor overhead staffs. It is concluded that the two methods provide bounding estimates on a range of manageable costs and provide reasonable bases for the utility rate adjustments necessary to pay for future decommissioning costs.

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### Generic Approaches to Estimating U.S. Decommissioning Costs

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 11; (pp. 149-156) (1991)

The estimation of decommissioning costs has certain common features, regardless of country or state. In the United States, the Nuclear Regulatory Commission has taken this into account as they have developed various generic estimates. This chapter summarizes three principal methods that have been used in cost estimates in the U.S.: (1) the linear extrapolation approach, (2) the unit cost factor approach, and (3) the detailed engineering approach. The linear extrapolation approach uses a simple proportion for estimating the cost of decommissioning a plant whose power output is different from the reference plant. Because decommissioning is a labor-intensive activity, and because the same basic types of effort are required to decommission a plant regardless of its size, this simple proportion grossly overestimates the cost to decommission a large plant. In the unit cost factor approach, a number of operations that are utilized in decommissioning are examined to develop a cost basis for a single (unit) operation. This approach provides reasonable estimates of direct manpower costs and radiation doses if careful attention is paid to the magnitude of the difficulty adjustment factors, and if those factors are allowed to vary between tasks. However, the usual approach is to assign conservative (large) values to these factors and apply the derived unit cost factor to every operation of that type throughout the decommissioning campaign. As a result, the composite estimate tends to be inflated. The detailed engineering method is based on an extensive analysis of the activities necessary to decommission two fairly large reference nuclear power stations that are typical of the large stations that were coming into service in the mid-1970s. The cost estimates derived from these studies are periodically updated for cost escalation and to reflect changes in regulatory requirements. Cost estimates derived through use of the detailed engineering method are generally lower than estimates produced by either of the other methods. This is due largely to different assumptions made about the size of the indirect staff labor component (overhead) required for decommissioning activities, and in the assumed duration of those activities. The disagreement on how large a staff is needed and for how long is unlikely to be resolved until a number of utilities have completed decommissioning of their plants.

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T.S. Snyder and G.A. Whitlow, Scientific Ecology Group, Inc., Oak Ridge, TN

**An Integrated Decontamination Process for Metals**

U.S. Patent A7,363,019; 18 pp. (June 8, 1989)

This patent describes an integrated process for decontaminating metals, in particular those metals used in the nuclear energy industry that are contaminated with radioactive material. This integrated process combines the technologies of melt refining and electrorefining to purify metals that cannot otherwise be decontaminated by singular application of either of the aforementioned refining processes.

**297**

Societe Francaise d'Energie Nucleaire, Paris, France

**Decommissioning of Fuel-Cycle Nuclear Facilities**

CONF-8803283; Proceedings of a Meeting, Paris, France, March 15, 1988. Societe Francaise d'Energie Nucleaire, Paris, France, 301 pp. (1988)

The papers presented in the meeting on the decommissioning of fuel-cycle nuclear facilities are focused on the following subjects: (1) regulations in France, (2) aspects to be considered, (3) dismantling techniques and methods, (4) organization and running of a site dismantling, (5) La Hague fuel reprocessing plant, (6) Marcoule alpha cells, (7) rinsing of the Eurochemic reprocessing plant, (8) large glove boxes components, (9) EDF dismantling operations, (10) nuclear fuel cycle, (11) aerosols and protection, (12) alpha radiators, (13) Dessel fuel reprocessing plant, and (14) the European perspective on decommissioning.

**298**

I.B. Souza, Centro de Desenvolvimento da Tecnologia Nuclear, Belo Horizonte, Brazil

**Aspects of Plasma Arc Cutting Process in the AISI 321 Type Stainless Steel**

DE88702611; 1 pp.

Some aspects of plasma arc cutting process in AISI 321 stainless steel, used in nuclear industry, are analyzed. The maximum values of the velocity of cutting and the minimum quantity of energy per unit of length necessary for the plasma were determined. The localization of irregularities in the cut surface was evaluated by surface roughness, using as a measurement parameter the distance between the sharpest salience and the deepest reentrance of the sample profile. The width of the layer from thermal action of the plasma was influenced by the velocity of cutting.

**299**

W. Stang and N. Eickelpasch, Kernkraftwerke Gundremmingen Betriebsgesellschaft GmbH, Gundremmingen, Federal Republic of Germany

**Decommissioning of Gundremmingen Unit A**

CONF-901034; Proceedings of the ASME/IEEE Joint Power Generation Conference, Boston, MA, October 21-25, 1990. American Society of Mechanical Engineers, New York, NY; (6 pp.) (1990)

Several nuclear power plants of the first generation in the world have finished their nuclear life and retired into the status of decommissioning. In 1980 this significant milestone was also settled for the nuclear power station Gundremmingen KRB A. The reasons for this decision are of general interest and will be explained. The experiences of dismantling, disassembling, decontaminating, and survey measuring resulting in the treatment of 3800 tons of materials released out of the controlled area is described. The recycling of carbon steel for the production of waste containers made of cast iron is an important technique to reduce waste volume and has been performed with 1500 tons of steel scrap. Finally, an outlook toward the intended steps in decommissioning the reactor building is given.

**300**

D.R. Steffes, West Valley Nuclear Services Company, Inc., West Valley, NY

**Status of Industry Standards for Decommissioning of Nuclear Facilities**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 437-442) (1988)

This paper discusses how several professional societies are preparing industry standards on nuclear facility decommissioning: (1) American Society for Testing and Materials Nuclear Technology Committee, Decommissioning Subcommittee, E10.03; (2) American Society of Mechanical Engineers Nuclear Quality Assurance (NQA) Committee Working Group on Decommissioning and the Reactor Services Committee Subcommittee on Decommissioning; and (3) Health Physics Society Standards Committee, working under the auspices of the American National Standards Institute. According to the author, the standards of these diverse groups mesh to form a cohesive body of guidance for planning a nuclear facility decommissioning.

**301**

A. Steringer and T. Moser, Commission of the European Communities, Luxembourg; Kraftanlagen AG, Heidelberg, Federal Republic of Germany

**Selection and Development of an Easy to Process Electrolyte for Decontamination by Electropolishing**

EUR-12383; 62 pp. (1989)

Three different organic electrolytes (formic acid-1, oxalic acid-2 and acetylacetone-3) and potassium bromide (KBr) as the auxiliary electrolyte were tested in the laboratory for electrochemically dissolving steel and stainless steel. The best results in the preliminary test series were attained with acetylacetone. It ranks among the first for current efficiency, with the produced acetylacetonates having the lowest solubility and settling out of the solution in the form of coarse crystalline products. Tests were made on radioactive reactor components using acetylacetone in a 400-A test facility, to verify and optimize the decontamination factors, the electrolyte service life and the produced waste volume, as well as the respective process parameters. The surface activity of the components ranged from 2 to 10 Bq/sq cm, and a decontamination factor of 30 was attained. The obtained specific waste volume is 1.1 l/sq m of decontaminated surface. A gamma-spectrometric evaluation revealed that the activity in the settled-out metallic acetylacetonate is five times higher than that in the electrolyte. It is only necessary to refill the spent acetylacetone, which then makes it possible to continue to use the electrolyte solution almost unrestrictedly.

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**State Regulation of Decommissioning Costs**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 5; (pp. 55-72) (1991)

Even though the Nuclear Regulatory Commission has jurisdiction over setting regulations governing financial assurance for decommissioning, the states have the specific responsibility of setting rates for fund accumulation. Each state must include many factors in determining the appropriateness of the rate requests from the utility companies under this jurisdiction, including plant size, date of decommissioning, and configuration of the nuclear component (single or multiple units). It also must decide on proper contingency factors, estimation methodology, the likelihood of early retirement, and whether fund accumulations will include amounts for the removal of nonradioactive components and site restoration. This chapter discusses the results of a survey of how 37 state utility companies treat these factors. It is concluded that decommissioning cost estimates used for ratemaking purposes vary widely from state to state, and that these differences are due largely to the lack of decommissioning experience. Most states have developed an approach for updating these estimates as experience develops.

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**Planning and Management for the Decommissioning of TRR-1/M1 Research Reactor**

Project Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities, Proceedings of the Technical Committee Meeting, July 29-August 2, 1991, Vienna, Austria. International Atomic Energy Agency, Vienna, Austria; (6 pp.) (August 1991)

The TRR-1/M1 research reactor is nearly 30 years old, and its shutdown will be completed by the beginning of 1992. In response to the Thai cabinet decision to relocate the reactor, the Office of Atomic Energy for Peace must develop a decommissioning plan for the reactor. This report covers the conceptual decommissioning plan for the TRR-/M1, including technical aspects, administrative considerations, and transportation and disposal of radioactive wastes resulting from the decommissioning process.

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**The Windscale Advanced Gas Cooled Reactor Decommissioning Project**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 180-188) (April 1990)

Dismantling the Windscale Advanced Gas-cooled Reactor (WAGR) is the United Kingdom's leading power reactor decommissioning project. The 100 MW(t) WAGR ceased operating in 1981 after 18 years of successful operation as a development reactor for the AGR nuclear power stations. Decommissioning began in 1982 with removal of fuel from the reactor core. Subsequently much waste treatment and engineering work has been done in preparation for the eventual removal of the reactor core in the early 1990s. Recent work has been concentrated on dismantling the shielded remote refueling machine, which weighs approximately 470 tons, and removing and partitioning the reactor top biological shield, a 60 ton steel and concrete structure. Dismantling the refueling machine was a difficult engineering task complicated by the presence of internal contamination and the requirements of working in a radiologically controlled area. At the stage when only the gantry of the refueling machine remained, the gantry was used as a platform for lifting the top biological shield out of its recess in the fueling floor. Prior to disposal, the top bioshield was then reduced in size by using conventional industrial techniques. A large amount of preparatory work preceded this operation, in particular the plasma arc tool cutting of the 253 refueling branches penetrating the bioshield.

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M.N. Syrkus and V.M. Tarasov

**Nuclear Facility Decommissioning and the Problem of Radioactive Wastes**

Ehnergokhoziaistvo za Rubezhom 6:12-21 (November-December 1989)

A complex of problems related to processing radioactive wastes formed as a result of nuclear facility decommissioning is considered. Approaches to the problem being considered in countries with high levels of nuclear power engineering development, the United States, France, and Japan in particular, are briefly characterized. It is shown that the volumes and characteristics of the wastes are determined by the type and capacity of the facilities decommissioned and also by the conditions of their operation. The conclusion is made that before the start of a nuclear facility decommissioning, it is necessary to create a complete set of devices and methods for waste processing such as waste conditioning, radiation control, and transport, as well as to develop the corresponding system of waste storage and disposal facilities.

**306**

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**Recent Topics on Radioactive Waste Treatment and Disposal Techniques and Nuclear Power Plant Decommissioning Techniques**

Hitachi Hyoron 72(10):1059-1068 (Ocotober 1990)

In Japan, a recent focus in the field of treatment and disposal of radioactive wastes generated in nuclear power stations is the development of a technology that facilitates the disposal of such wastes in a new low-level radioactive waste storage center that is expected to begin operation in 1992. This inorganic, cement-glass solidification treatment is excellent in its reduction of waste volume and its long-term stability. Two solidification plants are now under construction. In a parallel development, a removal control system was designed and tested. The removal control system does automatic nondestructive inspection when the solidified waste forms, packed in drums, are removed from the nuclear power stations for transport to the waste storage center. This system makes the cement-glass waste solidification technology of immediate practical use. To cope with future nuclear power plant decommissioning, advanced techniques of dismantling reactor core structures with underwater plasma arc cutting and of disassembling pressure vessels by gas cutting and other methods have been developed and tested. Some of these dismantling techniques were applied to the decommissioning of the Japan Power Demonstration Reactor. This increased efficiency in reactor disassembly encouraged the development of waste volume reduction.

307
V.M. Tarasov

**Decommissioning a Nuclear Power Plant with a LWR-Type Reactor in the Federal Republic of Germany**

Ehnergeticheskoe Stroitel'stvo za Rubezhom 3:17-20 (June 1989)

Results of investigations into organizational, technical, and financial aspects of decommissioning nuclear power plants (NPPs) with light water reactor-type reactors in the Federal Republic of Germany are presented. The Biblis-A NPP with a 200 MW(t) reactor and the Brunsbuettel NPP with an 805 MW(t) boiling water reactor are chosen as the objects of the investigation. Two variants of NPP decommissioning are considered: (1) reactor dismantling directly after the end of service life and (2) safe, 30-year storage of the NPP under surveillance, with the dismantling following storage. The STILLKO-1 program for estimation of total expenses to decommission a NPP and the improved STILLKO-2 program are developed. It is concluded that total expenses for decommissioning constitute 10-15% of those for NPP construction. Choice of NPP decommissioning variant is to a great extent defined by the projects that will make further use of the vacant site.

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V.M. Tarasov

**Economic Aspects of the Problem of Nuclear Power Plant Decommissioning**

Ehnergeticheskoe Stroitel'stvo za Rubezhom 5:7-11 (October 1989)

The problems of cost estimation for decommissioning the most common types of reactors used in nuclear power plants (NPP) are considered. The conclusion is made that at the current stage of nuclear power development, the consideration of safety should be primary when choosing a certain version of NPP decommissioning. The technical readiness for full-scale dismantling, as well as social, political, and economic factors should be taken into account for the final selection. The economic criterium, although not determining, plays an important role in the formation of national approaches to the solution of the problem considered.

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**Radium-226 Contamination in a Decommissioned Radon Laboratory**

Radiation Protection in Australia 8(2):36-37 (April 1990)

Measurements of atmospheric radon concentration, carried out at a number of sites in a decommissioned radon laboratory, have indicated the existence of open sources of radium-226, but the radium-226 is at a sufficiently low-level to allow use of the building, under ventilation conditions, as a work area for workers not trained to deal with radiation exposure.

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J. Timulak, I. Paulova, E. Strazovcova, and J. Pazitna, Vyskumny Ustav Jadrovych Elektrarni, Trnava, Czechoslovakia

**Decontamination Problems During Decommissioning of the A-1 Nuclear Power Plant**

CONF-8804333; The Management of Radioactive Wastes from Nuclear Power Plants, Proceedings of a Conference, Tale, Czechoslovakia, April 11-14, 1988, 327 pp.; (pp.47-61) (June 1988)

The results of phase analysis of contaminated layers of steel surfaces from both the primary and secondary circuit of the Bohunice A-1 nuclear power plant in Czechoslovakia are presented, together with the resul chemical and electrochemical decontamination. The schedule for decommissioning work, the corrosion effects of decontamination solutions, liquid radioactive waste management, and other problems are discussed in relation to decontamination during decommissioning.

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**Radioactive Waste Management Associated with the Decommissioning of Nuclear Power Plants and the Related Czechoslovak Research Programmes**

CONF-8804333; The Management of Radioactive Wastes from Nuclear Power Plants, Proceedings of a Conference, Tale, Czechoslovakia, April 11-14, 1988, 327 pp.; (pp. 276-286) (June 1988)

Problems concerning radioactive waste processing and disposal must be solved before starting the decommissioning of a nuclear power plant. Several problems of this kind have been solved in Czechoslovakia in relation to the decommissioning of the Bohunice A-1 nuclear power plant. The results of the problem solving are summarized and the problems to be solved within the scope of the state project, "Reconstruction and Decommissioning of Nuclear Power Plants," launched in 1988, are outlined.

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**Radioactive Waste Management at the A-1 Nuclear Power Plant After Its Decommissioning**

CONF-8804333; The Management of Radioactive Wastes from Nuclear Power Plants, Proceedings of a Conference, Tale, Czechoslovakia, April 11-14, 1988, 327 pp.; (pp. 238-255) (June 1988)

The present state of the radioactive waste processing at the Bohunice A-1 nuclear power plant and the preparation of new technologies are reported, and prospects to the year 1995 for waste formation from the decommissioning activities are outlined. Cementation and bituminization are the basic technologies that will be used for liquid radioactive waste processing. Depending on type, solid wastes will be pressed, remelted, incinerated or cemented. Liquid waste storage reservoirs are in poor condition; new reservoirs and purification plants will, therefore, be built. A survey table showing the kinds of wastes at the A-1 nuclear power plant, their amounts, and assumed formation, a table of existing and prepared technologies for radioactive waste treatment and the resulting volumes, an overview of the basic technologies of solid waste processing; and a survey of rooms on the premises of the nuclear power plant where barrels with solidified wastes can be temporarily stored are included.

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**United States Nuclear Regulatory Commission's Regulatory Oversight of Cleanup Operations at the Three Mile Island Unit 2 Station (1979-1989)**

CONF-891108; Recovery Operation in the Event of a Nuclear Accident or Radiological Emergency, Proceedings of an International Symposium, Vienna, Austria, November 6-10, 1989. International Atomic Energy Agency, Vienna, Austria, 657 pp.; (pp. 79-85) (1990)

As a result of the Three Mile Island Unit 2 (TMI-2) accident in March 1979, the U.S. Nuclear Regulatory Commission (NRC) established a program to carry out its regulatory oversight responsibilities during cleanup of the damaged facility. To achieve its primary objectives of safety assurance and environmental impact minimization, a dedicated organization was formed to conduct NRC reviews of cleanup planning and implementation at the utility. A discussion of the NRC regulatory approach regarding specific cleanup activities is presented. Additionally, NRC activities designed to facilitate the disposal of radioactive wastes and the dissemination of information to the public are discussed.

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**Investment Strategies for Externalized Nuclear Decommissioning Trusts**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 17; (pp. 217-229) (1991)

This chapter addresses several overall strategies of nuclear trust fund management by identifying the types of trusts, investment objectives, risk considerations, and the historical record. The author uses a fund adequacy analysis to examine expected cost growth, expected fund value, actual cost growth vs. expected cost growth, and actual fund value vs. expected fund value. While the long-term goal of such nuclear decommissioning trust (NDT) investment is definable, the practical ability to meet the goal is limited. Under current requirements, a realistic prognosis for a real return on investment is low, if not zero, even with the close monitoring that will be needed.

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B.J. Tymon, D.R. Goodill, and A.M. Fletcher, S.W. Atkins Engineering Services, Warrington, United Kingdom

**Does Radioactive Waste Have to be a Problem in Decommissioning?**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 196-200) (April 1990)

This paper describes how recent developments in radioactive waste management, such as the rapid increase in the costs of low-level waste disposal at Drigg, can influence decommissioning plans. This large increase in costs will now force contractors who are involved with the decommissioning/decontamination of plants or buildings to review waste disposal alternatives. A likely consequence will be that more use will be made of the special precautions burial option and the "nonradioactive" classification. There could also be developments incorporated into decommissioning operations which provide decontamination of low-activity, high-volume, low-level wastes. Optimization of disposal routes could also be obstructed by the continued reluctance of local councils to allow the dumping of waste from "nuclear" sites at local landfills.

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U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, TN

**Nuclear Reactors Built, Being Built, or Planned: 1990**

DOE/OSTI-8200-R54; 65 pp. (July 1991)

This report contains unclassified information about facilities built, being built, or planned in the United States for domestic use or export as of December 31, 1990. The Office of Scientific and Technical Information, U.S. Department of Energy (DOE), gathers this information annually from Washington headquarters and field offices of DOE, from the U.S. Nuclear Regulatory Commission, from the U.S. reactor manufacturers who are the principal nuclear contractors for foreign reactor locations, from U.S. and foreign embassies, and from foreign governmental nuclear departments. The book is divided into three major sections: Section 1 consists of a reactor locator map and reactor tables; Section 2 includes nuclear reactors that are operating, being built, or planned; and Section 3 includes reactors that have been shut down permanently or dismantled. Sections 2 and 3 contain the following classification of reactors: Civilian, Production, Military, Export, and Critical Assembly. Export reactor refers to a reactor for which the principal nuclear reactor is an American company - working either independently or in cooperation with a foreign company (Part IV, in each section). Critical assembly refers to an assembly of fuel and moderator that requires an external source of neutrons to initiate and maintain fission. A critical assembly is used for experimental measurements (Part V).

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U.S. Department of Energy, Washington, DC

**Field Office - Oak Ridge: Determination of Noncompetitive Financial Assistance**

Federal Register 56(136):32411 (July 16, 1991)

The U.S. Department of Energy (DOE) announces that pursuant to 10 CFR 600.7(b)(2)(i), it intends to issue on a noncompetitive basis a renewal to Vanderbilt University, Nashville, Tennessee, to continue providing academic training and sufficient on-the-job training to interns to enable them to function as professionals in the management of waste resulting from the decontamination and decommissioning of nuclear facilities. The period of renewal will be one year, and the estimated cost is $350,000. The internship program provides six people a year with proper academic training and sufficient on-the-job training. At the end of two years of academic work, the students are assigned for three months to a DOE-owned, contractor-operated facility or to a DOE prime contractor to gain first-hand experience in the field. The program is in it seventh year. To date, most of the graduating students have chosen work in the areas for which they have trained, thereby meeting the primary objective of the program.

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U.S. Department of the Navy, Washington, DC

**Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants Volume 2 - Comment Letters and Record of Public Hearings, Book 1, Exhibits 1-287**

Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants, Vol. 2, Book 1; 550 pp. (May 1984)

Volume 2 of the Final Environmental Impact Statement (EIS) presents comment letters and the records of public meetings conducted by the Navy on the Draft EIS. The public comment period on the draft extended from December 22, 1982 to June 30, 1983, but all comments received through August 31, 1983 are included. Volume 2 is divided into Book 1 and Book 2. Unique identification numbers have been assigned to each letter and statement, approximating a chronological sequence. Exhibits have been sidebarred to identify issues numbered according to the order in Volume 3 of the Final EIS. For example, Issue A.1 is the first issue in Section A of Volume 3. An Author Index and an Exhibit Index are provided at the end of Book 2 in Volume 2.

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U.S. Department of the Navy, Washington, DC

**Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants Volume 2 - Comment Letters and Record of Public Hearings, Book 2, Exhibits 288-724**

Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants, Vol. 2, Book 2; 584 pp. (May 1984)

Volume 2 of the Final Environmental Impact Statement (EIS) presents comment letters and the records of public meetings conducted by the Navy on the Draft EIS. The public comment period on the draft extended from December 22, 1982 to June 30, 1983, but all comments received through August 31, 1983 are included. Volume 2 is divided into Book 1 and Book 2. Unique identification numbers have been assigned to each letter and statement, approximating a chronological sequence. Exhibits have been sidebarred to identify issues numbered according to the order in Volume 3 of the Final EIS. For example, Issue A.1 is the first issue in Section A of Volume 3. An Author Index and an Exhibit Index are provided at the end of Book 2 in Volume 2.

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U.S. Department of the Navy, Washington, DC

**Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants Volume 3 - Responses to Issues from Public Review**

Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants, Vol. 3; 260 pp. (May 1984)

Volume 3 of the Final Environmental Impact Statement presents responses to 517 issues identified during the public review period for the Draft Environmental Impact Statement. These issues were received in letters and in statements made at the public meetings, as recorded in Volume 2. The issues are identified in Volume 2 by vertical lines in the margin and are given a serial number consisting of a Section Letter and number which relates the issue to the section in Volume 3 where the response is provided. In Volume 3, the issues and their responses are organized into sections which correspond to the major sections in the four chapters of the EIS and to selected appendices, based on the subject of each issue. Within these sections, the individual issues are listed in the order as shown in the Table of Contents. Each issue is stated, followed by a list of the respondents who identified the issue and the Navy's response to the issue. In some cases the issue has been summarized or paraphrased to include the comments of several individuals who worded the issue differently.

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U.S. Nuclear Regulatory Commission, Division of Engineering, Washington, DC

**Report on Waste Burial Charges: Escalation of Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities**

NUREG-1307 (Rev. 1); 34 pp. (October 1989)

One requirement placed upon nuclear power reactor licensees by the U.S. Nuclear Regulatory Commission (NRC) is for the licensees to periodically adjust the cost estimates for decommissioning their plants, in current year dollars, as part of the process to provide reasonable assurances that adequate funds for decommissioning will be available when needed. This report, which is scheduled to be revised annually, contains the development of a formula for escalating decommissioning cost estimates which is acceptable to NRC. The sources of information to be used in the escalation formula are identified, and the values developed for the escalation of radioactive waste burial costs by site and by year are given in this report. The licensees may use the formula, the coefficients, and the burial escalation factors from this report in their escalation analysis, or they may use an escalation rate at least equal to the escalation approach presented herein. The formula and its coefficients, together with guidance to the appropriate sources of data, are summarized in Chapter 2. The development of the formula and its coefficients are presented in Chapter 3. Price schedules for burial at currently operating burial sites for the year of issue of this report are given in Appendix A. The calculations performed to determine the burial cost escalation factors for each site for the year 1988 are summarized in Appendix B.

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U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

**Compilation of Contract Research for the Materials Engineering Branch, Division of Engineering: Annual Report for FY 1987**

NUREG-0975 (Vol. 6); 420 pp. (June 1988)

This report presents summaries of the research work performed during FY 1987 by laboratories and organizations under contracts administered by the Nuclear Regulatory Commission (NRC) Materials Engineering Branch, Office of Nuclear Regulatory Research. Each contractor has written a more complete and detailed annual report of their work which can be obtained by writing the NRC; however, this report is useful because it presents a summary of each contractor's efforts for the year combined into one volume. The work described is principally safety research for the primary systems of commercial light water power reactors, particularly with regard to reactor vessels, primary system piping, steam generators, nondestructive examination of primary components. It includes safety research for decommissioning and decontamination, on-site storage, and engineered safety features. Two reports are directly related to decommissioning. The first, "Evaluation of Nuclear Facility

Decommissioning Projects (ENFDP) Program," is an 11-page report from UNC Nuclear Industries and Westinghouse Hanford Company (both of Richland, WA). It describes a program to collect and analyze data on reactor decommissioning efforts such as work-hours expended, costs, radioactive wastes generated by type and volume, alternative methods of decommissioning, and occupational doses incurred during decommissioning. Data collected comes from the Shippingport Station Decommissioning Project and the Three Mile Island Unit 2 reactor in Pennsylvania, the Humboldt Bay Unit 3 reactor and the Northrop TRIGA facility in California, and three decommissioning projects in the Federal Republic of Germany. The second report relevant to decommissioning is "Radionuclide Source Term Measurements for Decommission Assessments." It describes work by Pacific Northwest Laboratory on a project to provide an up-to-date regulatory assessment of the radiological factors, criteria, and problem areas associated with the technology, safety, and costs pertaining to reactor decommissioning and waste disposal. This is accomplished through a measurements and appraisal program focused on: (1) radiological characterization during Shippingport Station decommissioning; (2) radiological characterization of intermediate-level wastes (highly activated reactor internal materials greater than Class C); (3) evaluation of the accuracy of predictive activation codes and methods; and (4) assessment of decommissioning waste disposal options.

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U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

**Assuring the Availability of Funds for Decommissioning Nuclear Reactors**

REG/G-1.159; PB-90-92650; 58 pp. (August 1990)

The general requirements for applications for license termination and decommissioning nuclear power, research, and test reactors are contained in 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities. On June 27, 1988, the Nuclear Regulatory Commission (NRC) published amendments to 10 CFR Part 50 (53 FR 24018) concerning specific criteria for decommissioning nuclear facilities. Amended 10 CFR 50.33(k), 50.75, and 50.82(b) require operating license applicants and existing licensees to submit information on how reasonable assurance will be provided that funds are available to decommission the facility. Amended section 50.75 establishes requirements for indicating how this assurance will be provided, namely the amount of funds that must provided, including updates, and the methods to be used for ensuring funds. This regulatory guide has been developed in conjunction with the rule amendments and was published for public comment in May 1989. This version incorporates, where appropriate, the public comments received. Its purpose is to provide guidance to applicants and licensees of nuclear power, research, and test reactors concerning methods acceptable to the NRC staff for complying with requirements in the amended rule regarding the amount of funds for decommissioning. It also provides guidance on the content and form of the financial assurance mechanisms indicated in the rule amendments.

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U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

**Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning under 10 CFR parts 30, 40, 70, and 72**

REG/G-3.66; 116 pp. (June 1990)

The purpose of this regulatory guide is to provide guidance acceptable to the U.S. Nuclear Regulatory Commission (NRC) staff on the information to be provided for establishing financial assurance for decommissioning and to establish a standard format for presenting the information. Use of the standard format will help ensure that the financial instruments contain the information required by 10 CFR Parts 30, 40, 70, and 72; aid the applicant and NRC staff in ensuring that the information is complete; and help persons reading the financial instruments to locate information. This guide addresses financial assurance for decommissioning of facilities under materials licenses granted under Parts 30, 40, 70, and 72. These parts include licensees in the following categories: Part 30, Byproduct Material; Part 40, Source Material; Part 70, Special Nuclear Material; and Part 72, Independent Spent Fuel Storage Installations.

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U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC

**Records Important for Decommissioning of Nuclear Reactors**

REG/G-90001149; 10 pp. (September 1989)

The general requirements for applications for license termination and decommissioning of nuclear reactors are contained in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." On June 27, 1988, the Nuclear Regulatory Commission (NRC) amended its regulations in 10 CFR Part 50 concerning specific criteria for decommissioning nuclear facilities (53 FR 24018). Amended paragraph 50.75(g) requires licensees to keep records of information important to safe and effective decommissioning in an identified location until the license is terminated by NRC. This section of the rule also identifies the kind of information NRC considers important to decommissioning. This draft regulatory guide has been developed in conjunction with the decommissioning rule amendments and is being published for public comment. The purpose of this guide is to provide guidance concerning the specific information that should be kept and maintained in the decommissioning records required by the rule amendments regarding the radiological conditions at the plant that could affect occupational and public health and safety during decommissioning.

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U.S. Nuclear Regulatory Commission, Washington, DC

**University of Kansas - Proposed Issuance of Orders Authorizing Disposition of Component Parts and Terminating Facility License**

Federal Register 56(77):16349-16350 (April 22, 1991)

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of orders authorizing the University of Kansas to dismantle the reactor facility and dispose of the component parts, along with termination of the Facility License No. R-78, in accordance with the licensee's application dated December 17, 1990. The first of these orders would be issued following NRC review and approval of the licensee's detailed plan for decontamination of the facility and disposal of the radioactive components, or some alternate disposition plan for the facility. This order would authorize implementation of the approved plan. Following completion of authorized activities and verification by NRC that acceptable radioactive contamination levels have been achieved, the NRC would issue a second order terminating the facility license and any further NRC jurisdiction over the facility. Findings required by the Atomic Energy Act of 1954 and NRC regulations will be made by NRC before the issuance of each order.

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U.S. Nuclear Regulatory Commission, Washington, DC

**University of Virginia - Proposed Issuance of Orders Authorizing Disposition of Component Parts and Terminating Facility License**

Federal Register 56(77):16350-16351 (April 22, 1991)

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of orders authorizing the University of Virginia to dismantle the CAVALIER training reactor and dispose of the component parts, along with termination of the Facility License No. R-123, in accordance with the licensee's application dated February 26, 1991. The first of these orders would be issued following NRC review and approval of the licensee's detailed plan for decontamination of the facility and disposal of the radioactive components, or some alternate disposition plan for the facility. This order would authorize implementation of the approved plan. Following completion of authorized activities and verification by NRC that acceptable radioactive contamination levels have been achieved, NRC would issue a second order terminating the facility license and any further NRC jurisdiction over the facility. Findings required by the Atomic Energy Act of 1954 and NRC regulations will be made by NRC before the issuance of each order.

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U.S. Nuclear Regulatory Commission, Washington, DC

**University of Utah - Proposed Issuance of Orders Authorizing Disposition of Component Parts and Terminating Facility License**

Federal Register 56(90):21508-21509 (May 9, 1991)

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of orders authorizing the University of Utah to dismantle the AGN-201M reactor facility and dispose of the component parts, along with termination of the Facility License No. R-25, in accordance with the licensee's application dated July 17 and 18, 1990. The first of these orders would be issued following the NRC review and approval of the licensee's detailed plan for decontamination of the facility and disposal of the radioactive components, or some alternate disposition plan for the facility. This order would authorize implementation of the approved plan. Following completion of authorized activities and verification by NRC that acceptable radioactive contamination levels have been achieved, NRC would issue a second order terminating the facility license and any further NRC jurisdiction over the facility. Findings required by the Atomic Energy Act of 1954 and NRC regulations will be made by NRC before the issuance of each order.

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U.S. Nuclear Regulatory Commission, Washington, DC

**Consideration of Amendment to Clintichem, Inc. License and Opportunity for Hearing, Clintichem, Inc.**

Federal Register 56(99):23601-23602 (May 22, 1991)

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of an amendment to Special Nuclear Materials License No. SNM-639, issued to Clintichem, Inc., for the use of special nuclear material at its facility located in Tuxedo, New York. Clintichem requested the amendment in a letter dated April 17, 1991, which referenced a decommissioning plan, an environmental report, and a radiological accident analysis that had previously been submitted on October 19, 1990. The amendment would authorize Clintichem to perform decommissioning of (1) the laboratory/hot cell building (Building 2) and associated structures; (2) areas in the reactor building (Building 1) and associated structures subject to this license amendment; and (3) the waste storage building (Building 6) and associated structures, all in accordance with Clintichem's decommissioning plan. Buildings 1, 2, and 6 contain radioactivity and radioactive components and waste generated as a result of operation in Clintichem's reactor facility from 1961-1990. On February 9, 1990, Clintichem reported the identification of an unmonitored release of radioactively contaminated water from the reactor building to an on-site retention pond. It was determined that this release resulted from the failure of part of a concrete wall in the gamma pit (a water-filled pool used for the temporary storage of radioactive materials). Clintichem voluntarily ceased operation of the reactor facility on February 9, 1990. On February 12, 1990, Clintichem informed NRC that another concrete vessel on-site (the hold-up tank, located in Building 1 and used to allow the decay of short-lived isotopes in the reactor coolant) also apparently had developed a leak. On February 13, NRC issued an order requiring that the Clintichem facility remain shut down until existing leaks were identified and repaired. On May 31, 1990, NRC was informed that Clintichem had decided to decommission the reactor and radiochemical processing facilities and was preparing a decommissioning plan. On January 14, 1991, NRC noted in the Federal Register that it was considering issuance of an order authorizing Clintichem to dismantle the reactor facility, dispose of the waste, and terminate License No. R-81.

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**Melting of Uranium-Contaminated Metal Cylinders by Electroslag Refining**

Nuclear Technology 79:328-337 (December 1987)

This article examines melt refining as a means of uranium decontamination of metallic wastes by electroslag refining. Electroslag refining was selected because it is easy to scale up to the necessary industrial levels. Various thicknesses of iron and aluminum cylinders with uranium concentrations close to that of actual metallic wastes were melted by adding effective fluxes for decontamination. Thin-walled iron and aluminum cylinders with a fill ratio (electrode/mold cross-section ratio) of 0.05 could be melted, and the energy efficiency obtained was 16-25%. The ingot uranium concentration of iron obtained was 0.01-0.015 ppm, which was close to the contamination level of the as-received specimen, while for aluminum it was 3-5 ppm, which was a few times higher than the as-received specimen contamination level of about 0.9 ppm. To melt a thin aluminum cylinder in a steady state with a fill ratio of 0.05, instantaneous electrode driving response control was needed. Electroslag refining gave better decontamination and energy economization results than resistance furnace melting.

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**Safety Analyses for Disposal of Decommissioning Wastes**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 336-338) (1988)

Finland produces about 35% of its electricity from its two nuclear power plants. The power companies are responsible for management of the resulting radioactive wastes, including final disposal. Repositories for low- and medium-level operational reactor waste will be excavated in the bedrock at the two power plant sites. The preliminary safety analysis reports for these repositories were presented to the authorities in December 1986. For the Olkiluoto power plant, the authorities permitted the construction license in March 1988 and excavation of the repository has been started. At the other nuclear power plant, Loviisa, where there is plenty of storage capacity for low- and medium-level waste, the repository will be constructed in the 1990s. The operating licenses of the nuclear power plants require that updated plans for decommissioning be presented to the authorities every fifth year. The updated decommissioning plans, presented in December 1987, include comprehensive safety analyses of the final disposal of decommissioning wastes.

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**Nuclear Power Plants - Shall We Decommission or Reconstruct Them?**

Jaderna Energie 36(10):363-367 (October 1990)

The economic effectiveness of different variants for extending the operation time of nuclear power plants to beyond their economic lifetime is discussed. The methodology of assessment of this effectiveness must rely on the general criterion of development of the power system and must take into account all system bonds and effects as well as the dynamic character of the problem. Model calculations gave evidence that postponement of the high capital expenditure for the construction of a new power source can be profitable even if this calls for expenditure of other single costs. In principle the reconstruction of nuclear power plants seems to be the more advantageous variant.

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**Secondary Emissions from Underwater Plasma-Arc Cutting of Stainless Steel for Nuclear Decommissioning**

Journal de Physique 51(C-5):145-152; CONF-9009297; European Congress on Thermal Plasma Processes and Materials Behaviour at High Temperature, Odeillo, France, September 12-14, 1990 (September 1990)

Detailed properties and yields of gaseous and particulate emissions from underwater plasma-arc cutting of stainless steel have been measured as part of an interlaboratory program to assess the repeatability of the cutting process and secondary emissions. Specimens of 304 stainless steel that are 20 mm and 40 mm thick were cut with argon/nitrogen gas at water depths of 0.5 m and 1.0 m. Good repeatability was obtained. Aerosol particles evolved were significantly enriched in Mn and, to a lesser extent, in Cr but reduced in Ni and Co. Size distributions and concentrations of these particles were measured. Fine particles collected in the water were shown to be partially dissolved by acidity caused by absorption of nitrogen oxides in the water. Emissions of NO and H-2 were also quantified.

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**Explosive Cutting of Thick-Walled Steel Pipes in the HDR Reactor**

Nuclear Engineering and Design 118(1):87-97 (March 1990)

Cutting of a real pipe system by explosive technique has been tested and proven feasible inside the HDR reactor containment. Circumferential cuts were performed on a pipe loop with 400 mm diameter, 20 mm wall thickness. The cutting tool consists of an array of modular explosive charges which are wrapped around the pipe in a collar-like mode. Mounting of the charge array is performed manually in a quick and easy way. To retain the fragments originating from the charge, a fragment-retaining structure was used in the experiments. This ring shaped structure (fragment catcher) also substantially reduces the explosive blast load on the immediate vicinity. However, handling a fragment catcher of 700 kg weight requires a pulley or crane and, consequently, rather restricts the application of this technique. In addition to the control of the fragments and the blast wave in the area of the cutting operation, the transient load on the pipe system and on the reactor containment structure has to be kept below critical values. In principle, the load produced in pipe cutting by explosive methods must be subdivided into the local and the global loads acting on the HDR. The various contributions of the dynamic loading have been measured and analyzed carefully. Fourier analyses conducted on the basis of displacement measurements indicate the frequencies. The ground mode of the long pipe branch is between 2.5 Hz and 3.5 Hz; that of the second ground mode is between 7.5 Hz and 8.5 Hz. Predictions of the axial momentum based on short-pipe-segment cutting are too high by a factor of 3 when compared to the calculated deflection of the separated pipe ends, although the calculated pipe excitation frequencies (2.5 to 10 Hz) are in rather good agreement with the measurement.

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H. Weichselgartner

**Development of Decontamination Foil**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 218-224) (April 1990)

This paper describes the development of an in situ decontamination procedure by applying onto the contaminated surface (in a one-step or multistep process) pasty, chemically aggressive agents causing dilution and adsorption of the contaminant and then hardening to form a strippable foil. The use of this foil will result in the following advantages: (1) shorter operation duration resulting in lower personnel doses, (2) reduction of the arising secondary waste volume, (3) optimal conditioning of the radioactive waste due to its fixation in a solid (foil), and (4) an accidental contamination in a controlled area can easily be fixed and covered, avoiding its propagation.

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**Historical Lessons for Nuclear Decommissioning Trust Fund Investment**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 16; (pp. 205-216) (1991)

One way we can attempt to judge the best investment strategy for nuclear decommissioning trust funds (NDTs) is to examine past after-tax returns of various investment options. No passively managed asset class allowed in qualified NDTs has produced real after-tax returns. Thus an active, rather than a passive, investment strategy that utilizes short- and intermediate-term fixed-income securities (i.e., municipal bonds) is advised. This strategy allows the fund to reinvest maturing securities at higher yields during periods of inflation and rising rates. In periods of stable interest rates, the shorter term maturities yield about 80 percent of the income of long-maturity municipal bonds.

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**Technical Exchange in Robotics for Reactor Decommissioning Between the USA and Japan**

ORNL/FTR-2667; 17 pp. (September 22, 1987)

Japan is one of the world leaders in artificial intelligence and robotics. A major collaborative program already exists between the Oak Ridge National Laboratory effort in advanced teleoperations and the Japanese interest in remote handling for nuclear fuel reprocessing. The subject visit was initiated by the Japanese to foster a broader exchange in the area of autonomous robotics and intelligent machines. Following the visit, JAERI proposed a similar initiative in intelligent autonomous machines. This effort has been formally approved as a 10-year program, and was initiated in its first year with eight full-time researchers. Beginning next year, it is expected that this effort will grow to its maximum level of 25 researchers per year. Prospects for potential technical exchange in artifical intelligence and robotics appear promising. Additional opportunities may exist in remote handling for reactor decommissioning.

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**An Overview of the AEA Technology Decommissioning Research and Development Programme**

Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works, I.L. Whyte (ed.), Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp.; (pp. 123-131) (April 1990)

AEA Technology (AEA) is currently undertaking several major decommissioning projects in the United Kingdom and is committed to the development of methods, techniques and

equipment to perform the wide and varied range of tasks specific to decommissioning ventures. AEA has implemented a full research and development program to support its current and future decommissioning projects. The topics covered in the program include such items as plant radioactivity assessment, dismantling techniques and methodology, remote manipulation, viewing systems, ventilation, filtration, and decontamination techniques. The AEA program serves two broad objectives: (1) it supports existing decommissioning projects and (2) it provides a generic data base to be used in future decommissioning tasks. This paper gives examples of some of the typical problems encountered in the decommissioning of Windscale Advanced Gas-cooled Reactor and the development areas associated with their solution.

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**Decommissioning and Demolition 1990: Decommissioning Offshore, Onshore Demolition and Nuclear Works**

Proceedings of the Second International Conference, Manchester, United Kingdom, April 24-26, 1990. Thomas Telford Limited, London, United Kingdom, 254 pp. (April 1990)

These proceedings include the following reports relating to decommissioning and decontamination of nuclear facilities: (1) Abrasive Waterjets - An Adaptable Tool for Different Purposes in Hazardous Environments; (2) Controlled Use of Explosive Techniques in the Decommissioning of Nuclear Facilities; (3) An Overview of the AEA Technology Decommissioning Research and Development Program; (4) Design Improvement to Facilitate Decommissioning of P.W.R.; (5) Examination and Long-Term Assessment of Nuclear Power Plant Structures; (6) Decommissioning of Nuclear Installations; (7) Planning and Management of Stage 1 Dismantling of B16 Pile Chimney, Sellafield; (8) Regulatory Aspects of Nuclear Reactor Decommissioning; (9) Decommissioning of Fuel Pie Caves at Berkeley Nuclear Laboratories; (10) The Windscale Advanced Gas Cooled Reactor Decommissioning Project; (11) The Decommissioning of the Niederaichbach Power Plant; (12) Does Radioactive Waste Have to be a Problem in Decommissioning? (13) Decommissioning of Final Product Storage Buildings at a Former Reprocessing Plant; (14) Development of Decontamination Foil; and (15) Preparations for Decommissioning the Windscale Piles. Individual papers are recorded separately.

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D.H. Williams, Entergy Operations, Inc., Little Rock, AR

**The Expanding Decommissioning Focus: A Comparison of Coal and Nuclear Costs**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 23; (pp. 295-304) (1991)

As nuclear power plant decommissioning cost estimation techniques have matured, the estimates themselves have grown larger. This has caused at least two reactions. One is alarm at the "uniquely" enormous costs of decommissioning nuclear power plants which had been "hidden" until after the plants were operating. Another is the recognition by ratemaking authorities that decommissioning costs are part of the cost of producing power. This recognition has led to the realization that significant costs are also associated with the decommissioning of nonnuclear facilities. As a result, decommissioning cost estimates are beginning to be made for large coal-fired power plants. The existence of these estimates permits an evaluation of just how "unique" the large costs of decommissioning nuclear power plants really are. After comparing detailed decommissioning cost estimates for three nuclear power plants and two coal-fired plants, the author concludes that coal plant decommissioning costs (computed on a dollars per megawatt capacity basis) are 14 percent higher than nuclear plant decommissioning costs.

It is argued that the nuclear industry is setting the standard among industries in planning and preparing for decommissioning, and that the nuclear experience provides information that can be applied to the decommissioning of all types of facilities.

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A.B. Wolbarst, H. Terada, and A.C.B. Richardson (eds.), Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan; U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

**Residual Radioactivity and Recycling Criteria**

EPA/520/1-90-013; CONF-8909236; Proceedings of a Workshop, St. Michaels, MD, September 27-28, 1989, 311 pp. (September 1989)

Over the next several decades, many thousands of radioactively contaminated sites in the U.S., Japan, and other countries will become candidates for cleanup and decommissioning. Suitable public health and environmental protection criteria and standards for decontamination and decommissioning programs are lacking or incomplete in virtually all countries. Health protection criteria are needed so that sites can be cleaned up and made available for other uses, either with or without restrictions based upon residual activity. On September 27 and 28, 1989, the Office of Radiation Programs of the Environmental Protection Agency and the Japan Atomic Energy Research Institute together sponsored a workshop on Residual Radioactivity and Recycling Criteria in St. Michaels, Maryland. Thirty-one government and private-sector radiological health experts from the U.S. and eleven from Japan participated. Topics for discussion fell into five general categories: (1) extent of the cleanup problem, (2) impacts of cleanup technologies and economics of criteria, (3) health effects, (4) desirable characteristics of criteria, and (5) recycling of materials and equipment. These proceedings include 26 published papers and a meeting summary, along with a transcription of the closing panel discussion. This document is published for use as a resource document in the further development of criteria for the cleanup of radioactively contaminated sites.

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

**Federal Regulation of Decommissioning Economics**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 4; (pp. 45-54) (1991)

As we move deeply into the new territory of large-scale decommissioning, countries around the world are looking to the United States for guidance and experience in establishing their own approaches. In the U.S., the Nuclear Regulatory Commission (NRC) is the lead agency responsible for public health and safety issues linked to commercial nuclear power. This responsibility includes assuring adequate funds for decommissioning. This chapter introduces us to the regulations and positions of the NRC regarding decommissioning financing. The issues include why the NRC chose external funding mechanisms, how the funds should be collected and invested, the relationship between the NRC and state agencies, and fund assurance in a variety of cases including possible accident and bankruptcy. While this discussion serves as an overview of the most significant aspects of decommissioning financing, it also introduces us to the relationships of the NRC with the states and electric utility companies.

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E.M. Wright and A.P. Colquhoun, British Nuclear Fuels Limited, Sellafield, Seascale, Cumbria, United Kingdom

**Dose Reduction During Remote Dismantling of Pile Chimneys - BNFL Sellafield**

Remote Systems Technology, Proceedings of the 38th Conference, Washington, DC, November 1990. American Nuclear Society, La Grange Park, IL, Vol. 2; (pp. 10-14) (1990)

British Nuclear Fuels plc (BNFL) operates the Sellafield Nuclear Fuel Reprocessing Plant located in Cumbria, UK as part of its complete nuclear fuel cycle business. In addition to this and the construction of new reprocessing and waste treatment plants, BNFL has built up an extensive decommissioning capability. This has been necessary to enable the company to implement a program of decommissioning its redundant plants and structures. One aspect of this decommissioning program includes the decommissioning of the Windscale Pile Reactor Chimneys. This presentation will review the use of a Remote Handling Machine and a Radio Controlled Excavator to dismantle parts of the chimneys. The presentation will also reference the use of other remotely controlled equipment as an essential part of the dose control strategy.

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R. Xianwen, China Institute for Radiation Protection, Taiyuan, Shanxi, People's Republic of China

**Electropolishing of Radionuclide-Contaminated Metal Materials**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (18 pp.) (June 1991)

This paper reports research work done in China on electropolishing and electrolyte selection. Electropolishing is one of the techniques that needs development for metal decontamination during the decommissioning of nuclear facilities. Preliminary research was carried out under International Atomic Energy Agency sponsorship. The results showed that a neutral salt solution, for example NaNO3, is suitable for use as an electrolyte during the electropolishing process. When the concentration of NANO3 if 200 g/l, current density is 0.5 A per sq cm, and distance between electrodes is within 2-20 mm, electropolishing will yield satisfactory results. When current density was higher than 0.5 A per sq cm and distance between electrodes was less than 20 mm, the current efficiency was higher than 40%. During the process, hydroxides were generated, precipitating iron, nickel, and chromium. If precipitants were added to the spent electrolytic solution, most of the radionuclides were removed, making the electrolytic solution reusable. An NaNO3 solution used as an electrolyte is compatible with existing liquid waste treatment systems. After electropolishing, the metal surface was smooth enough to prevent recontamination.

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S. Yanagihara, S. Asida, and H. Usui, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Dismantling of JPDR Internals Using Under Water Plasma Arc Cutting Technique Operated by Robotic Manipulator**

Atomnaya Tekhnika za Rubezhom 12:30-32 (December 1989)

The technology of underwater plasma cutting and the design of a robotic manipulator, successfully used to dismantle the Japanese Power Demonstration Reactor (JPDR) internals, are considered. Of the 882 workdays required, 124 workdays were spent in preparation, 220 on equipment mounting, 368 on equipment dismantling, 89 on equipment disassembling, and 81 on decontamination procedures. Total personnel irradiation dose did not exceed 0.05 R (10(E-4) Sv).

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S. Yanagihara, F. Hiraga, and H. Nakamura, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Dismantling Techniques for Reactor Steel Piping**

Nuclear Technology 86(2):159-167;

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (8 pp.) (August 1989)

This reprint of a journal article relates how two cutting techniques have been developed for dismantling the pipes connected to the Japan Power Demonstration Reactor (JPDR) pressure vessel. They are the rotary disk knife cutting system for dismantling relatively large pipes such as the primary cooling system and the shaped explosive cutting system for cutting relatively small pipes in air or water. Basic cutting tests were performed to determine the optimum characteristics of the cutting systems and to conduct a safety evaluation by studying the effects of blasting on surrounding areas. Mock-up tests confirmed the applicability of the newly developed dismantling systems for JPDR dismantlement by successfully cutting test pipes with these systems.

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S. Yanagihara, Y. Seiki, and H. Nakamura, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Dismantling Techniques for Reactor Steel Structures**

Nuclear Technology 86(2):148-158; Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (10 pp.) (August 1989)

In this reprint of a journal article, it is reported that two techniques have been developed for the underwater dismantlement of the steel components of the Japan Power Demonstration Reactor (JPDR): (1) the plasma arc for dismantling the reactor internals and (2) the arc saw for cutting the reactor pressure vessel. In parameter tests, the cutting capability for these techniques was improved and the characteristics of the by-products were evaluated to enable proper design of the water purification and dross collection systems. Mock-up tests, conducted as final systems performance checks, proved that the cutting systems developed are practical for dismantling the JPDR steel structures.

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S. Yanagihara and M. Tanaka, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Estimating the Costs for Japan's JPDR Project**

The Energy Journal 12: Special Issue - Nuclear Decommissioning Economics: Estimates, Regulation, Experience and Uncertainties, M.J. Pasqualetti and G.S. Rothwell (eds.). Energy Economics Educational Foundation, Washington, DC, 346 pp., Ch. 10; (pp. 135-148) (1991)

This chapter addresses various aspects of the methodological approaches being developed throughout the world to estimate decommissioning costs. Japan's strategy for reactor decommissioning reflects the geographic and economic positions peculiar to the country. The Japan Power Demonstration Reactor (JPDR) decommissioning program is in the process of establishing a decommissioning data base and a cost estimation methodology, as well as developing new technology for reactor decommissioning. Various information about the JPDR dismantling has been accumulated in the decommissioning data base, which will be used for: (1) planning future decommissioning of commercial nuclear power reactors; (2) verifying the developed code system for management of reactor decommissioning; and (3) managing the ongoing JPDR dismantling. The computer code system developed in this program is expected to contribute to studying cost estimation and the optimization of decommissioning plans for commercial nuclear power reactors.

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M. Yokota and T. Hoshi, Japan Atomic Energy Research Institute, Tokai Research

Establishment, Tokai, Ibaraki, Japan

**Status of the JPDR Decommissioning Program**

Decontamination and Decommissioning of Nuclear Facilities - Phase II, Proceedings of the Second Research Coordination Meeting, Coordinated Research Program of the International Atomic Energy Agency, June 10-14, 1991, Vienna, Austria; (17 pp.) (June 1991)

The Japan Power Demonstration Reactor (JPDR) was the first power reactor in Japan. The JPDR decommissioning program was initiated in 1981. Actual dismantling of the JPDR was begun in 1986 with the goal of putting the site in Stage 3 condition. As of the end of 1990, almost all of the steel reactor components, including the reactor pressure vessel (RPV) and its internals, have been removed. Components of the primary cooling system and the auxiliary system in the reactor containment and the turbine building were also removed. Highly activated RPV components were removed using remotely-operated cutting techniques. About 700 tons of steel components (35% of the total for the entire JPDR) have been dismantled so far. Through December 1990, total manpower expenditure for the decommissioning project was 39,000 work-days and total radiation exposure to workers was 0.26 man-Sv. The labor cost so far agrees well with the planned value, while radiation exposure was within about half of what was planned. Lower radiation exposure resulted from appropriate planning and radiation control management, as well as the use of remotely-operated cutting systems. The next phase of the program will include the demolition of the biological shield concrete and buildings.

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M. Yokota and M. Ishikawa, Japan Atomic Energy Research Institute, Tokai Research Establishment, Tokai, Ibaraki, Japan

**Underwater Arc Saw Gets to Work on the Vessel at Japan's JPDR**

Nuclear Engineering International 35(434):35-36 (September 1990)

The decommissioning program of the Japan Power Demonstration Reactor, a 90 MW(t) boiling water reactor, was initiated in 1981 by the Japan Atomic Energy Research Institute. Actual dismantling began in 1986. All reactor internals and pipes connected to the pressure vessel have now been successfully dismantled using an underwater plasma arc cutting system, a shaped explosive cutting system, and a rotary disk knife cutting system, as well as conventional tools. Cutting of the reactor pressure vessel using an underwater arc saw started at the beginning of May after the preparatory work had been completed. Preparation for this stage included removing the components around the vessel (stabilizers and thermal insulation) and installing and adjusting the arc saw cutting system.

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C. Yu, Y.C. Yuan, A.J. Zielen, and A. Wallo III, Argonne National Laboratory, Argonne, IL; U.S. Department of Energy, Washington, DC

**Residual Radioactive Material Guidelines: Methodology and Application**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 633-639) (March 1989)

A methodology to calculate residual radioactive material guidelines was developed for the U.S. Department of Energy (DOE). This methodology is coded in a menu-driven computer program, RESRAD, which can be run on IBM or IBM-compatible microcomputers. Seven pathways of exposure are considered: (1) external radiation, (2) inhalation, (3) ingestion of plant foods, (4) ingestion of meat, (5) ingestion of milk, (6) ingestion of aquatic foods and (7) ingestion of water. The RESRAD code has been applied to several DOE sites to calculate soil cleanup guidelines. This experience has shown that the computer code is easy to use and very user-friendly.

# FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

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**A Bill to Require that Remediation of Certain Defense-Related Radioactive Wastes Currently Located in the City and County of St. Louis, Missouri to be Conducted in a Nonurban Area**

U.S. House Resolution HR-4533, Introduced in the House of Representatives, One Hundredth First Congress, Second Session, April 18, 1990; 4 pp. (1990)

The U.S. Department of Energy (DOE) is directed to remove all radioactive wastes generated by the Manhattan Engineer District and the Atomic Energy Commission as a result of the processing of uranium and thorium for use in nuclear weapons production from St. Louis and St. Louis County, Missouri. DOE is further directed to transport the wastes to a nonurban site in Missouri for remediation and processing and to restore the properties from which the wastes have been removed to a condition capable of supporting industrial, commercial, recreational, or other appropriate uses.

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D. Adler, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**The FUSRAP Environmental Compliance Assessment Program**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 567-580) (April 1990)

Recent years have seen an increased emphasis on U.S. Department of Energy efforts to ensure that all of its facility operations are conducted in compliance with all applicable environmental requirements. This presentation focuses on an internal program set up to assess compliance with these requirements by the Formerly Utilized Sites Remedial Action Program. The assessment process, site-specific findings, and subsequent corrective actions are discussed.

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Agency for Toxic Substances and Disease Registry, Atlanta, GA

**Health Assessment for W.R. Grace and Co., Inc./Wayne Interim Storage Site, Wayne, Passaic County, New Jersey, Region 2 - CERCLIS No. NJD891837980 - Final Report**

PB-90-260118; 17 pp. (July 30, 1990)

The Wayne Interim Storage Site (WISS), a Superfund site, was formerly owned and operated by the W.R. Grace Company, which used the site for extracting thorium from monazite ore and then concentrating the thorium. Off-site contamination occurred via soil transport during storm run-off to drainage areas. The main contaminants at WISS are radionuclides in the thorium-232 and uranium-238 decay series. The site is currently owned by the U.S. Department of Energy (DOE). Large sections of vicinity properties were remediated (excavated) to DOE radiological standards from 1985 through 1987. The WISS was prepared to serve as an interim site for the storage of low-level radioactive soil. Radioactive materials remain on the WISS and in the railroad spur area. This site is considered to be of potential public health concern by Agency for Toxic Substances and Disease Registery and New Jersey Department of Health. This site is not presently being considered for follow-up health study or evaluation.

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Agency for Toxic Substances and Disease Registry, Atlanta, GA

**Health Assessment for Maywood Chemical Company, Maywood, Bergen County, New Jersey, Region 2 - CERCLIS No. NJD980529762 - Final Report**

PB-90-260126; 24 pp. (July 30, 1990)

The Health Assessment for the Maywood Chemical Company Site includes the Maywood Interim Storage Site (MISS), the Ballod property, the Scanel site, residential properties, and the Sears warehouse and its adjacent properties, all of which are located in the towns of Maywood and Rochelle Park of Bergen County, New Jersey. These site are at different investigative or remedial stages under the auspices of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE). EPA is responsible for chemical characterization and cleanup operations, whereas DOE is primarily in charge of radiologic analysis and remediation. On the basis of the information reviewed, the Agency for Toxic Substances and Disease Registery and New Jersey Department of Health have concluded that the Maywood Chemical site is of public health concern because humans have probably been exposed to hazardous substances at concentrations that may result in adverse health effects. As noted in the Environmental Contamination and Physical Hazards section, human exposure to chemical and radiological contamination is probably occurring and has probably occurred in the past via the use of contaminated groundwater and contact with contaminated soils. Before suspected areas of contamination are developed, both on-site contamination and the potential off-site migration of contaminants need to be fully evaluated. Developing an area without characterizing potential contamination could lead to an adverse impact on the public health.

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Argonne National Laboratory, Argonne, IL

**Engineering Evaluation/Cost Analysis for the Proposed Removal of Contaminated Materials from Pad 1 at the Elza Gate Site, Oak Ridge, Tennessee**

DOE/OR/23701-37.2; 38 pp. (September 1990)

This engineering evaluation/cost analysis (EE/CA) has been prepared to support the proposed removal action for radioactively-contaminated concrete and soil beneath a building on privately owned commercial property in Oak Ridge, Tennessee. The property, known as the Elza Gate site, became contaminated with uranium-238, radium-226, thorium-232, thorium-230, and decay products as a result of the Manhattan Engineer District is storing uranium ore and ore processing residues at the site in the early 1940s. The U.S. Department of Energy (DOE) is responsible for cleaning up of the property under its Formerly Utilized Sites Remedial Action Program. DOE plans to remove the cracked and worn concrete pad and contaminated subsoil beneath the pad, after which the property owner/tenant will provide clean backfill and new concrete. Portions of the pad and subsoil are contaminated and, if stored or disposed of improperly, may represent a potential threat to public health and the environment. The EE/CA report is the appropriate documentation for the proposed removal action, as identified in guidance from the Environmental Protection Agency. The objective of the EE/CA report, in addition to identifying the planned removal action, is to document the selection of response activities that will mitigate the potential for release of contaminants from the property into the environment and minimize the related threats to public health and the environment.

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Bechtel National, Inc., Oak Ridge, TN

**Colonie Interim Storage Site Annual Site Environmental Report for Calendar Year 1989**

DOE/OR/20722-261; 97 pp. (May 1990)

The environmental monitoring program, which began in 1984, was continued in 1989 at the Colonie Interim Storage Site (CISS), a U.S. Department of Energy (DOE) facility located in Colonie, New York. CISS is currently used as an interim storage area for contaminated materials removed during cleanup of the site and vicinity properties. Contamination is the result of low-level radioactive wastes produced during manufacture of uranium products (shielding components, counterweights, projectiles) by National Lead Industries during the period 1958 to 1980. Hazardous chemicals from the company's electroplating operations are also present. CISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to identify and decontaminate or otherwise control sites where residual radioactive materials (exceeding current guidelines) remain from the early years of the national atomic energy program or from commercial operations. Bechtel National, Inc., project management contractor for FUSRAP, conducts remedial actions and environmental monitoring at this site and vicinity properties. The monitoring program at CISS measures external gamma radiation levels, total uranium, and radium-226 concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater. Chemical sampling of groundwater began in January 1989; the information is considered baseline data. The radiation dose was calculated for a hypothetical, maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the conservative scenario described in this report, this hypothetical individual receives an annual external exposure approximately equivalent to 2% of the DOE radiation protection standard. The cumulative dose to the population within an 80 kilometer (50 mile) radius of CISS which results from radioactive materials at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources.

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Bechtel National, Inc., Oak Ridge, TN

**St. Louis Airport Site Environmental Report for Calendar Year 1989**

DOE/OR/20722-262; 99 pp. (May 1990)

The environmental monitoring program, which began in 1984, was continued in 1989 at the St. Louis Airport Site (SLAPS) in St. Louis County, Missouri. SLAPS is a former Manhattan Engineer District/Atomic Energy Commission facility used for storage of uranium ore processing residues. SLAPS and its vicinity properties were designated for cleanup as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy (DOE) program to identify and decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the national atomic energy program. The DOE environmental monitoring program at SLAPS is conducted by Bechtel National, Inc., project management contractor for FUSRAP. The monitoring program at SLAPS measures radon concentrations in air; external gamma dose rates; and uranium, thorium, and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater samples. The radiation dose was calculated for a hypothetical, maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the scenario described in this report, this hypothetical individual would receive an annual external exposure approximately equivalent to 6% of the DOE radiation protection standard. Results of 1989 monitoring show that SLAPS is in compliance with the DOE radiation protection standard.

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Bechtel National, Inc., Oak Ridge, TN

**Hazelwood Interim Storage Site Annual Environmental Report for Calendar Year 1989**

DOE/OR/20722-263; 97 pp. (May 1990)

The environmental monitoring program, begun in 1984, was continued in 1989 at the Hazelwood Interim Storage Site (HISS), a U.S. Department of Energy (DOE) facility located in the city of Hazelwood, Missouri. Originally known as the Cotter Corporation site on Latty Avenue, HISS is currently used for storage of soils contaminated with residual radioactive material. Materials previously stored at the site include uranium ore residues and uranium- and radium-bearing process wastes, primarily Colorado raffinate and leached barium sulfate. These materials were removed from the site by 1973. Contaminated soils from cleanup of vicinity properties have been stored at HISS since 1984. HISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the national atomic energy program. The environmental monitoring program and remedial actions at the site and vicinity properties are being conducted by Bechtel National, Inc., project management contractor for FUSRAP. The monitoring program at HISS measures radon concentrations in air; external gamma radiation levels; and uranium, thorium, and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater samples. The radiation dose was calculated for a hypothetical, maximally exposed individual to assess the site's potential effect on public health. Based on the scenario described in this report, this hypothetical individual would receive an annual external exposure approximately equivalent to 1.5% of the DOE radiation protection standard (100 mrem/yr). Results of 1989 monitoring show that HISS is in compliance with the DOE radiation protection standard.

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Bechtel National, Inc., Oak Ridge, TN

**Middlesex Sampling Plant Environmental Report for Calendar Year 1989**

DOE/OR/20722-265; 95 pp. (May 1990)

The environmental monitoring program, which began in 1980, was continued in 1989 at the former Middlesex Sampling Plant (MSP) site, a U.S. Department of Energy (DOE) facility located in the Borough of Middlesex, New Jersey. The MSP site is currently used as an interim storage area for contaminated soils and materials removed during cleanup of site and vicinity properties. Contamination is the result of use as a sampling, storage, and shipment facility for uranium, thorium, and beryllium ores from 1943 to 1967. MSP is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to identify and decontaminate or otherwise control sites where residual radioactive materials (exceeding current guidelines) remain from the early years of the national atomic energy program or from commercial operations. Bechtel National, Inc., project management contractor for FUSRAP, conducts environmental monitoring at this site. The monitoring program at MSP measures radon concentrations in air; external gamma radiation levels; and uranium and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater samples. The radiation dose was calculated for a hypothetical maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the conservative scenario described in this report, this hypothetical individual receives an annual external exposure approximately equivalent to 2.3% of the DOE radiation protection standard. The cumulative dose to the population within an 80 kilometer (50 mile) radius of MSP which results from radioactive materials at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources.

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Bechtel National, Inc., Oak Ridge, TN

**Wayne Interim Storage Site Environmental Report for Calendar Year 1989**

DOE/OR/20722-266; 95 pp. (May 1990)

The environmental monitoring program, which began in 1984, was continued in 1989 at the Wayne Interim Storage Site (WISS), a U.S. Department of Energy (DOE) facility located in Wayne Township, New Jersey. WISS is currently used as an interim storage area for contaminated materials removed during cleanup of the site and vicinity properties. Contamination is the result of wastes produced during processing of monazite sands to extract thorium and rare earth elements, an activity carried out at the site by Rare Earths, Inc. and W.R. Grace and Company from 1948 to 1971. MISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to identify and decontaminate or otherwise control sites where residual radioactive materials (exceeding current guidelines) remain from the early years of the national atomic energy program or from commercial operations. Bechtel National, Inc., project management contractor for FUSRAP, conducts remedial actions and environmental monitoring at this site and vicinity properties. The monitoring program at WISS measures thoron (Rn-220) and radon concentrations in air; external gamma radiation levels; and thorium, uranium, and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater. The radiation dose was calculated for a hypothetical, maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the conservative scenario described in this report, this hypothetical individual receives an annual external exposure approximately equivalent to 2.7% of the

DOE radiation protection standard. The cumulative dose to the population within an 80 kilometer (50 mile) radius of WISS which results from radioactive materials at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources.

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Bechtel National, Inc., Oak Ridge, TN

**Maywood Interim Storage Site Environmental Report for Calendar Year 1989**

DOE/OR/20722-267; 113 pp. (May 1990)

The environmental monitoring program, which began in 1984, was continued in 1989 at the Maywood Interim Storage Site (MISS), a U.S. Department of Energy (DOE) facility located in the Borough of Maywood and the Township of Rochelle Park, New Jersey. MISS is currently used for storage of soils contaminated with low-level radioactivity. MISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to identify and decontaminate or otherwise control sites where residual radioactive materials (exceeding current guidelines) remain from the early years of the national atomic energy program or from commercial operations. Bechtel National, Inc., project management contractor for FUSRAP, conducts remedial actions and environmental monitoring at this site and vicinity properties. The monitoring program at MISS measures thoron (Rn-220) and radon concentrations in air; external gamma radiation levels; and thorium, uranium, and radium concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater. The radiation dose was calculated for a hypothetical, maximally exposed individual to verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess its potential effects on public health. Based on the conservative scenario described in this report, this hypothetical individual receives an annual external exposure approximately equivalent to 1% of the DOE radiation protection standard. The cumulative dose to the population within an 80 kilometer (50 mile) radius of MISS which results from radioactive materials at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources.

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Bechtel National, Inc., Oak Ridge, TN

**Quality Assurance Plan for Field Sampling at the Middlesex Plant, Middlesex, New Jersey**

DOE/OR/20722-273; 47 pp. (December 1990)

Former operations at the Middlesex Sampling Plant (MSP), Middlesex, New Jersey, resulted in the contamination of residential and municipal vicinity properties as well as the DOE-owned facility itself. These vicinity properties were decontaminated and restored in 1980 and 1981 during Phase I of the Middlesex remedial action program. Residue and rubble were placed in an interim storage pile near the southwest corner of the site. In 1984, a second storage pad was constructed for 12,000 cu m of material excavated from the Middlesex Municipal Landfill during that year. In 1986, an extension was added to the second storage pad to accommodate an additional 12,000 cu m of material excavated from the landfill in that year. Field sampling activities will be conducted to determine whether the two storage piles contain hazardous waste as defined by the Resource Conservation and Recovery Act and to identify chemical constituents in on-site soil requiring corrective action. This quality assurance project plan outlines the quality assurance/quality control requirements ensuring the defensibility and integrity of analytical data generated by these sampling activities.

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Bechtel National, Inc., Oak Ridge, TN

**Field Sampling Plan for the Middlesex Sampling Plant, Middlesex, New Jersey,**

DOE/OR/20722-274; 68 pp. (December 1990)

Former operations at the Middlesex Sampling Plant (MSP), Middlesex, New Jersey, resulted in the contamination of residential and municipal vicinity properties as well as the U.S. Department of Energy-owned facility itself. These vicinity properties were decontaminated and restored in 1980 and 1981 during Phase I of the Middlesex remedial action program. Residue and rubble were placed in an interim storage pile near the southwest corner of the site. In 1984, a second storage pad was constructed for 12,000 cu m of material excavated from the Middlesex Municipal Landfill during that year. In 1986, an extension was added to the second storage pad to accommodate an additional 12,000 cu m of material excavated from the landfill in that year. Field sampling activities will be conducted to determine whether the two storage piles contain hazardous waste as defined by the Resource Conservation and Recovery Act and to identify chemical constituents in on-site soil requiring corrective action. This field sampling plan provides guidance for all field work by defining the sampling methods to be used. The field sampling plan includes a site history and description.

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Bechtel National, Inc., Oak Ridge, TN

**Community Relations Plan for Removal of Contaminated Material at the Elza Gate Site, Oak Ridge, Tennessee**

DOE/OR/20722-281; 29 pp. (January 1991)

This community relations plan identifies and addresses issues of community concern regarding the contamination present at the Elza Gate site in Oak Ridge, Tennessee, and supports the engineering evaluation/cost analyses (EE/CAs) for removal actions proposed by the U.S. Department of Energy (DOE) to clean up the contaminated materials. This plan also outlines the community relations activities and schedule for implementation at Elza Gate. The Elza Gate site, sometimes referred to as the Melton Lake Industrial Park, is an 8-ha (20-acre) privately owned commercial property located in the southeastern portion of the city of Oak Ridge, Tennessee. The property is divided into nine parcels. Parcels 1 through 4 contain concrete pads that formerly served as warehouse foundations where uranium ore and processing residues were stored. A building has been erected on one pad. Low-level radioactive contamination exceeding current guidelines and some polychlorinated biphenyl contamination are present on-site. Two removal actions are being proposed for decontamination of the site as the only current Formerly Utilized Sites Remedial Action Program site in the state. This community relations plan has been prepared to guide DOE in proceeding with a community relations program tailored to the needs of the Oak Ridge community, to ensure that the local public has input to decisions about actions, and to keep the public informed about the progress of those actions. Basic community relations activities will include, but are not limited to (1) identifying a contact person, (2) establishing an administrative file, (3) establishing an administrative record, (4) scheduling a 30-day comment period on EE/CAs, (5) preparing responsiveness summaries, (6) posting public notices about the proposed removal actions, and (7) preparing and distributing fact sheets. The plan is a public document and is available for review through the DOE Information Resource Center located at Lee Wan & Associates, 105 Broadway, Oak Ridge, Tennessee 37830.

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Bechtel National, Inc., Oak Ridge, TN

**Hazelwood Interim Storage Site Annual Environmental Report for Calendar Year 1990**

DOE/OR/21949-283; 121 pp. (August 1991)

Environmental monitoring of the U.S. Department of Energy (DOE) Hazelwood Interim Storage Site (HISS) and surrounding area began in 1984. This document describes the environmental monitoring program, the program implementation, and the monitoring results for 1990. Also included are a brief site history, site description, land use summary, and climatological data. The environmental monitoring program at HISS includes sampling networks for radon concentrations in air; external gamma radiation exposure; and total uranium, radium-226, and thorium-230 concentrations in surface water, sediment, and groundwater. Additionally, several nonradiological parameters are measured in groundwater. Results from the 1990 environmental monitoring program demonstrated that the concentrations of contaminants of concern were all well below applicable standards. Site activities in 1990 were limited to maintenance. HISS was in compliance with all applicable regulations during 1990 and has remained in compliance since 1984, when the environmental monitoring program was begun.

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Bechtel National, Inc., Oak Ridge, TN

**St. Louis Airport Site Annual Environmental Report for Calendar Year 1990**

DOE/OR/21949-288; 114 pp. (August 1991)

Environmental monitoring of the U.S. Department of Energy (DOE) St. Louis Airport Site (SLAPS) and surrounding area began in 1984. This document describes the environmental monitoring program, the program implementation, and the monitoring results for 1990. Also included are a brief site history, site description, land use summary, and climatological data. The environmental monitoring program at SLAPS includes sampling networks for radon concentrations in air; external gamma radiation exposure; and total uranium, radium-226, and thorium-230 concentrations in surface water, sediment, and groundwater. Additionally, several nonradiological parameters are measured in groundwater. Results from the 1990 environmental monitoring program demonstrated that the concentrations of contaminants of concern were all well below applicable standards. Site activities in 1990 were limited to maintenance. SLAPS was in compliance with all applicable regulations during 1990 and has remained in compliance since 1984, when the environmental monitoring program was begun.

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Bechtel National, Inc., Oak Ridge, TN

**Niagara Falls Storage Site Annual Environmental Report for Calendar Year 1990**

DOE/OR/21949-289; 152 pp. (August 1991)

Environmental monitoring of the U.S. Department of Energy (DOE) Niagara Falls Storage Site (NFSS) and surrounding area began in 1981. NFSS is part of the Formerly Utilized Sites Remedial Action Program, a DOE program to decontaminate or otherwise control sites contaminated with residual radioactive material produced during the early years of the national atomic energy program or by commercial operations causing conditions that Congress has authorized DOE to remedy. Environmental monitoring systems at NFSS include sampling networks for radon concentrations in air; external gamma radiation exposure; and total uranium and radium-226 concentrations in surface water, sediment, and groundwater. Additionally, several nonradiological parameters are measured in groundwater. During 1990, site activities included maintenance of contaminated soils in the storage piles, a limited chemical characterization, and installation of three wells. NFSS was in compliance with all applicable DOE orders and federal and state regulations, as has been the case since 1984, when the environmental monitoring program and remedial action began.

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**Health and Safety Plan for the Waste Consolidation Work at the Niagara Falls Storage Site**

DOE/OR/20722-291; 29 pp. (May 1991)

The health and safety plan (HSP) for the Formerly Utilized Sites Remedial Action Program (FUSRAP) provides the practical framework for health and safety in all project operations. The HSP for the Niagara Falls Storage Site (NFSS) provides the site-specific information required to implement an effective health and safety program. The NFSS HSP makes site-specific information readily available to site employees and increases the effectiveness of the site health and safety program. The purpose of this HSP is to provide work-specific health and safety guidance during a short-term project to consolidate waste from three on-site sources into the main waste containment structure (WCS). The three on-site sources of waste are (1) the contents of approximately sixty 55-gal drums, (2) 3500 cu yd contained in two small interim piles northeast of the WCS, and (3) a location to be excavated that contains both radioactive and chemical contamination. This project will be completed in approximately 2 months, after which this HSP will cease to be in force.

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W.D. Cottrell and R.F. Carrier, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of the Radiological Survey of the Carpenter Steel Facility, Reading, Pennsylvania**

ORNL/RASA-89/3; 19 pp. (July 1990)

In 1944, experimental uranium-forming work was conducted by Carpenter Technology Corporation at the Carpenter Steel Facility in Reading, Pennsylvania, under contract to the Manhattan Engineer District. The fabrication method, aimed at producing sounder uranium metal and improving the yields of rods from billets, was reportedly soon discarded as unsatisfactory. As part of the Department of Energy's (DOE) efforts to verify the closeout status of facilities under contract to agencies preceding DOE during early nuclear energy development, the site was included in the Formerly Utilized Sites Remedial Action Program (FUSRAP). At the request of DOE, the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory performed a radiological assessment survey in July and August 1988. The purpose of the survey was to determine if past operations had deposited radioactive residues in the facility, and whether those residuals were in significant quantities when compared to DOE guidelines. The survey included gamma scanning; direct measurements of alpha activity levels and beta-gamma dose rates; sampling for transferable alpha and beta-gamma residuals on selected surfaces; and sampling of soil, debris, and currently used processing materials for radionuclide analysis. All survey results were within DOE FUSRAP guidelines derived to determine the eligibility of a site for remedial action. These guidelines are derived to ensure that unrestricted use of the property will not result in any measurable radiological hazard to the site occupants or the general public.

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**Radiological Survey of the Former Aeroprojects Facility, West Chester, Pennsylvania**

ORNL/RASA-90/5; 5 pp. (October 1990)

The former Aeroprojects, Inc., Facility is located at 200-T East Rosedale Avenue, West Chester, Pennsylvania. The facility was under contract to the Atomic Energy Commission (AEC) beginning in 1951 to investigate the use of ultrasonic energy in a variety of manufacturing procedures. An unknown quantity of alloys and compounds of aluminum, beryllium, mercury, thorium, and uranium were used on the site. In the mid 1960s, work for the AEC tapered off and Aeroprojects began doing research and development under other government contracts. It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such sites or facilities comply with current DOE guidelines. Therefore, at the request of DOE, a radiological survey of this site was conducted in May 1988. The survey included a gamma scan of the interior of the building that had been used during the contract work and the area outdoors immediately adjacent to the building. The survey results show that all gamma exposure rates approximated typical background levels found in the southeastern Pennsylvania area and, furthermore, were well within DOE guidelines. However, recently discovered information suggests that small amounts of radioactive residuals may have been buried on-site. The areas where these suspected burials would have occurred are included in areas planned to be remediated by the current owners.

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**Results of the Radiological Survey at the Former Heppenstall Company Site, 4620 Hatfield Street, Pittsburgh, Pennsylvania**

ORNL/RASA-89/19; 18 pp. (January 1991)

As part of the Formerly Utilized Sites Remedial Action Program, the U.S. Department of Energy (DOE) is implementing a program to determine the radiological conditions at sites that were used to process radioactive materials under contract with DOE predecessor agencies. During 1955, the former Heppenstall Company site in Pittsburgh, Pennsylvania was used by an Atomic Energy Commission contractor to process approximately 100,000 lbs of normal uranium metal. Because of insufficient records to document cleanup procedures and to verify the radiological condition of the site, DOE requested a survey. The radiological survey discussed in this report for the site was conducted by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory in July of 1989. The survey included a surface gamma scan of the warehouse, collection of indoor soil and dust samples and one outdoor soil sample, and measurement of direct and transferrable alpha and beta-gamma activity. Results of this radiological assessment indicate no detection of radiation levels or radionuclide concentrations above DOE guidelines.

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**Results of the Radiological Survey at 7 Hancock Street, Lodi, New Jersey (LJ027)**

ORNL/RASA-87/32; 17 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 7 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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**Results of the Radiological Survey at 5 Hancock Street, Lodi, New Jersey (LJ029)**

ORNL/RASA-87/33; 13 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 5 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. Results of the survey demonstrated concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of the material originating from the MCW site.

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**Results of the Radiological Survey at 24 Long Valley Road, Lodi, New Jersey (LJ048)**

ORNL/RASA-87/35; 17 pp. (August 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 24 Long Valley Road, Lodi, New Jersey, was conducted during 1985 and 1986. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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**Results of the Radiological Survey at 9 Hancock Street, Lodi, New Jersey (LJ028)**

ORNL/RASA-87/36; 13 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 9 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. Some radionuclide measurements were greater than typical background levels in the northern New Jersey area. However, results of the survey demonstrated no radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria.

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**Preliminary Site Survey Report for the Former Elza Gate Warehouse Area, Oak Ridge, Tennessee**

ORNL/RASA-89/4; 27 pp. (September 1989)

In the early 1940s, the operations of the

Manhattan Engineer District in support of the war effort included the importing and refining of foreign uranium ore. The radium-bearing sludges that resulted from the refining process were stored in warehouses in Oak Ridge, Tennessee, while awaiting further disposition. Later on, other radioactive materials such as tailings, oxide residues, and slag were also stored in the five warehouses. Following the removal of the stored materials to other facilities, the Atomic Energy Commission's Y-12 Plant in Oak Ridge used the warehouses for a period of time before the site was decontaminated and released for unrestricted use under criteria current at that time. However, because guidelines for use of such sites have become more stringent since previous cleanups, and because it is the policy of DOE to verify that such sites are in compliance with current guidelines, a radiological survey was conducted on parcels 1 through 4 of the property by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory in March 1989. Survey results show that widespread residual radioactivity from former operations remains on the property, primarily in outdoor soil and as surface contamination on three of the original concrete pads, one of which is inside the present building. Residuals are in excess of DOE criteria for cleanup under the Formerly Utilized Sites Remedial Action Program. Because results also indicate that spillover contamination to parcels 5 through 9 on the property is probable, further surveying of these areas may be appropriate.

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**Results of the Preliminary Radiological Survey at B&T Metals, 425 West Town Street, Columbus, Ohio**

ORNL/RASA-89/1; 31 pp. (October 1990)

As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites that were formerly used by DOE's predecessor agencies. The preliminary radiological survey discussed in this report for the B&T Metals site in Columbus, Ohio, is part of the FUSRAP effort and was conducted at the request of DOE by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory in 1988 and 1989. In the 1940s the B&T Metals site was used to provide extrusion of uranium billets into rods in support of Manhattan Engineering District (MED) operations. The preliminary radiological survey included a surface gamma scan; collection of dust, debris, and soil samples; measurement of direct and transferable alpha and beta-gamma activity; and air sampling. Results of this radiological assessment indicate that the property contains residual radioactivity from MED activities in concentrations that exceed remedial action guidelines.

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**Results of the Radiological Survey at the Former Ore Storage Site, Palmerton, Pennsylvania (PP001)**

ORNL/TM-11218; 123 pp. (December 1990)

As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites used by the department's predecessor agencies. The radiological survey discussed in this report for the former ore storage site in Palmerton, Pennsylvania, is part of the FUSRAP effort. The survey was conducted at the request of DOE by Oak Ridge National Laboratory (ORNL) in 1988. In 1953 and 1954 the Atomic Energy Commission (AEC) established an ore stockpile on the property of the New Jersey Zinc Corporation in Palmerton, Pennsylvania. Approximately 57 truckloads (about 360 tons) were stored at this site and remained there until 1973, when AEC initiated a cleanup program. The 1988 ORNL radiological survey included a gamma scan at the ground surface, gamma measurements at discrete locations at the surface and 1 m above the surface, gamma logging of 80 auger holes, and collection of 161 surface and subsurface soil samples. Of these 161 soil samples, 98% were below DOE guidelines for Ra-226 concentrations in soil. Interpretation of the data suggests small, isolated spots of residual ore. The data indicate that it is highly unlikely that an individual living or working on this site could receive a radiation dose approaching the 100 mrem annual limit. However, it is suggested that DOE evaluate potential exposures at this site to ensure compliance with their policy that all exposures to radiation are reduced to levels that are as low as reasonably achievable.

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**Preliminary Results of the Radiological Survey at the Former DOW Chemical Company Site - Madison, Illinois**

ORNL/TM-11552; 51 pp. (December 1990)

During the late 1950s and early 1960s, the former Dow Chemical Company plant, now owned and operated by Spectrulite Consortium, Inc., supplied materials and provided services for the Atomic Energy Commission (AEC) under purchase orders issued by the Mallinckrodt Chemical Company, a primary AEC contractor. Information indicates that research and development work involving gamma-phase extrusion of uranium metal was conducted at the Dow Chemical Plant. Because documentation establishing the current radiological condition of the property was unavailable, a radiological survey was conducted by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory (ORNL) in March 1989. The survey included (1) measurement of indoor gamma exposure rates, (2) collection and radionuclide analysis of dust and debris samples, and (3) measurements to determine alpha and beta-gamma surface contamination. The results of the survey demonstrate that Building 6, the area in which uranium extrusion and rod-straightening work occurred, is generally free of radioactive residuals originating from former DOE-sponsored activities. However, U-238- and Th-232-contaminated dust was found on overhead beams at the south end of Building 6. These findings suggest that past DOE-supported operations were responsible for uranium-contaminated beam dust in excess of guidelines in Building 6. However, the contamination is localized and limited in extent, rendering it highly unlikely that under present use an individual working in or frequenting these remote areas would receive a significant radiation exposure. ORNL recommends that additional scoping survey measurements and sampling be performed to further define the extent of indoor uranium contamination southward to include Building 4 and northward throughout Building 6.

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**Results of Mobile Gamma Scanning Activities in Tonawanda, New York**

ORNL/RASA-90/6; 21 pp. (December 1990)

During the 1940s, the Linde Air Products Division of Union Carbide operated a plant in Tonawanda, New York, for the Manhattan Engineer District (MED) and the Atomic Energy Commission. Uranium production and some nickel processing were conducted at the site. It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such sites or facilities comply with current DOE guidelines. Guidelines for release and use of such sites have become more stringent as research since previous cleanups has provided more information. The Formerly Utilized Sites Remedial Action Program (FUSRAP) was established as part of that effort to confirm the closeout status of facilities under contract to agencies preceding DOE. Under the FUSRAP program, the Linde site has been previously investigated to determine the extent of on-site radiological contamination. As a precaution to ensure that no residual radioactive materials were transported off-site, DOE requested that the Oak Ridge National Laboratory survey the area in the vicinity of the Linde Plant, the waste water treatment facility on Tower Road, the Sheridan

Park Fire Stat' ›n (District 4), and the Tonawanda Landfill to assess whether any residual radioactive could be detected. The survey was conducted during the week of April 3, 1990. Results of analysis of soil samples from the Tonawanda Landfill revealed slightly elevated concentrations of U-238 and Ra-226 suggestive of residuals from former Linde Plant operations. It is therefore recommended that additional surveys be conducted of the landfill property and also of Sheridan Creek from south of the Linde property to its confluence with the Niagara River. These surveys should include the measurement of gamma radiation levels and a radionuclide analysis of silt samples.

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**Radiological Risk Assessment of a Radioactively Contaminated Site**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 513-518) (1990)

A limited-scope preliminary assessment of radiological risk has been conducted at a radioactively contaminated site located in the southeastern part of the city of Oak Ridge, Tennessee. The site is known as the Elza Gate site and was used by the Manhattan Engineering District in the early 1940s as a storage area for uranium ore and ore-processing residues. Five warehouses with concrete pad floors were used for storing such materials. None of the original structures remain, but the concrete pads upon which the warehouses were built are still in place. The site is currently being developed for use as an industrial park. The radiological risk assessment is based on the available preliminary radiological characterization data for the site and will provide useful input to the remedial action planning for the site.

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**Radioactive Risk Assessment for Radioactive Contamination at a Landfill Site**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Depa·tment of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 355-366) (April 1990)

A limited-scope preliminary assessment of radiological risk has been conducted for a landfill site at the Seaway Industrial Park in Tonawanda, New York, where radioactive residues resulting from past uranium ore processing operations of the Manhattan Engineering District are present. Potential radiation doses to an individual under different scenarios have been predicted using the RESRAD computer code. The assessment provides useful input to the remedial action planning for the site that is currently underway. The results of this preliminary analysis show that the current conditions case for Area A of the landfill site does not meet DOE radiation protection criterion of less than 100 mrem/yr dose to an individual member of the public. After the erosion of the thin cover on Area A in about 150 years, the dose to an individual in the resident/farmer scenario is more than two times the dose limit; for the industrial worker scenario, the dose is about three quarters of the dose limit. Given DOE commitment to as low as reasonably achievable potential dose levels, letting the current conditions remain "as is" in Area A is not a viable alternative in the long term.

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**Waste Management Aspects of the Formerly Utilized Sites Remedial Action Program**

CONF-900694; Proceedings of the Canadian Radiation Protection Association Eleventh

Annual Meeting, Saint John, Canada, June 11-13, 1990; (22 pp.) (1990)

The remedial actions at the 31 sites that are currently in the Formerly Utilized Sites Remedial Action Program could generate an estimated total volume of about 1.7 million cu yd of radioactive waste, roughly equivalent to the total volume of low-level waste that has been disposed of at all the commercial disposal sites in the United States so far. The success of the program depends not only on remediating these sites but also on finding a permanent disposal place for the wastes. The disposal site options include existing Department of Energy reservations, commercial disposal sites, and new disposal sites. It may be necessary to develop new disposal facilities for these wastes because of several factors related to geographical location, transportation cost, environmental impacts, and sociopolitical considerations. Waste disposal is currently estimated to represent about one-third of the total estimated one billion dollar cost for the whole program. Waste management aspects within the program are diverse. The sites range in size from small sites used only for storage operations to large-scale decommissioned industrial facilities where uranium processing and other operations were carried out in the past. Currently, three sites are on the National Priorities List for remediation.

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**Waste Management and Environmental Compliance Aspects of a Major Remedial Action Program**

CONF-910270; Waste Management '91: Working Towards a Cleaner Environment - High-Level Waste, Low-Level Waste, Mixed Waste and Environmental Restoration, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 24-28, 1991; (21 pp.) (1991)

The Formerly Utilized Sites Remedial Action Program (FUSRAP) is one of four major programs undertaken by the U.S. Department of Energy (DOE) to remediate various sites where radiological contamination remained from programs conducted during the nation's early years of research and development in atomic energy. The remedial actions at the 33 sites that are currently in FUSRAP could generate an estimated volume of about 1.6 million cubic meters of radioactive waste. Waste disposal is currently estimated to represent about one-third of the estimated $2.1 billion cost for the entire program over its duration. Waste management aspects within the program are diverse. The sites range in size from small areas used only for storage operations to large-scale decommissioned industrial facilities where uranium processing and other operations were carried out in the past. Currently, four sites are on the National Priorities List for remediation. Remedial actions at FUSRAP sites have to satisfy the requirements of both the National Environmental Policy Act and the Comprehensive Environmental Response, Compensation, and Liability Act, as amended. In addition, a number of federal, state, and local laws as well as executive orders and DOE orders may be applicable or relevant to each site. Several key issues currently face the program, including the mixed waste issue, both from the environmental compliance (with the Resource Conservation and Recovery Act) and the disposal technology perspectives.

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**Demonstration Experience with an Abrasive Blasting Technique for Decontaminating Concrete Pads**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 489-495) (May 4, 1990)

A demonstration was performed at the Elza Gate site in Oak Ridge for decontaminating a radioactively contaminated concrete pad with a portable abrasive blasting system. The system utilizes a rotating blast wheel that scours the concrete surface with metal abrasive. The metal abrasive, pulverized concrete dust, and contaminants rebound into a separator chamber. The reusable metal abrasive is recycled, and the pulverized media are removed to an integral dust collection system. The exhaust is high efficiency particulate air filtered to minimize release of airborne contaminants. The system was set up to remove 1.6 mm of concrete layer per pass. A decontamination factor of about 0.5 was achieved with the first pass; two subsequent passes achieved decontamination factors of 0.3 and 0.2 respectively. However, the technique had limited success in reducing contamination around the cracks and seams in the concrete where the higher activity levels of contamination were detected during the radiological survey before the cleanup. The technique can be successful and cost effective in decontaminating large areas of low contamination; however, careful characterization and planning are necessary.

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**Progress and Issues in FUSRAP and SFMP**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 119-123) (March 1989)

The Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Surplus Facilities Management Program (SFMP) have made steady progress in cleaning up facilities and sites across the United States. Over the past year (1988), FUSRAP completed remediation of sites in Illinois, New Jersey, and New York. At many other sites, work continued on characterizing the contamination to enable remedial action plans, environmental compliance documentation, and designs to be developed. For SFMP, the Shippingport project continued to be a model of cost and schedule management with preparation of the reactor pressure vessel for transport to the Hanford Reservation for disposal. On the Weldon Spring Project in Missouri, interim remedial actions were started to address immediate environmental concerns while site characterization continued. DOE also made steady progress in smaller projects such as the Mound project in Ohio and the Experimental Boiling Water Reactor in Illinois. As with any program involving the management of radioactive waste, issues and problems arise which require solution to permit progress. For FUSRAP and SFMP, some of the current issues are locating disposal sites for wastes, meeting environmental compliance requirements, managing risks and uncertainties, negotiating tripartite agreements, and planning in advance for potential mixed waste disposal.

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**Results of the Radiological Survey at State Route 17 and Becker Avenue, Maywood, New Jersey (MJ033)**

ORNL/RASA-88/36; 9 pp. (March 1990)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the U.S. Department of Energy, a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses.

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**Results of Radiological Surveys of 20 Borough-Owned Properties, Maywood, New Jersey (MJ050)**

ORNL/RASA-90/4; 9 pp. (August 1990)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid 1950s. At the request of the U.S. Department of Energy, a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma-radiation levels and soil sampling for radionuclide analyses. The survey of these 20 borough-owned properties in Maywood, New Jersey was conducted during 1987. Survey measurements indicate that none of the properties contained radioactive contamination. Slightly elevated gamma exposure rates in several areas were related to the presence of ashes or to natural materials used in the construction of buildings and asphalt surfaces.

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**Results of the Radiological Survey at 72 Sidney Street, Lodi, New Jersey (LJ067)**

ORNL/RASA-88/18; 24 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residues used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 72 Sidney Street, Lodi, New Jersey, was conducted during 1987. Results indicated concentrations of thorium-232 slightly in excess of the DOE remedial action criterion for subsurface soil. This finding, coupled with the fact that adjacent properties have been designated by DOE for remedial action, and that the old Lodi Brook streambed is apparently beneath the property, suggests that it be considered for inclusion in the DOE remedial action program.

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**Results of the Radiological Survey at 4 Hancock Street, Lodi, New Jersey (LJ060)**

ORNL/RASA-88/25; 13 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S.

Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 4 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. Gamma logging results during this survey and during a previous survey conducted by Bechtel National, Inc., strongly indicated radionuclide concentrations in subsurface soil in excess of DOE remedial action criteria. This finding, coupled with the fact that adjacent properties have been found to be contaminated and that Lodi Brook apparently flows under the property, suggests that it be considered for inclusion in the DOE remedial action program.

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**Results of the Radiological Survey at 133 Maywood Avenue, Maywood, New Jersey (MJ025)**

ORNL/RASA-88/30; 15 pp. (October 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 133 Maywood Avenue, Maywood, New Jersey, was conducted during 1987. The survey results demonstrate that all radionuclide concentrations and measurements conform to DOE remedial action criteria. All values are at or below typical background values found in northern New Jersey.

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**Results of the Radiological Survey of the Property at Main Street and Highway 46, Lodi, New Jersey (LJ074)**

ORNL/RASA-88/39; 13 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, located at the intersection of Main Street and Highway 46, Lodi, New Jersey, was conducted during 1987. While some radiological measurements taken at the vacant lot at the intersection of Main Street and Highway 46 were greater than background levels typically encountered in the northern New Jersey area, no radiation levels or radionuclide concentrations exceeded the applicable DOE criteria. The survey results demonstrate that the radiological condition of this property conforms to DOE guidelines for remedial action.

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**Results of the Radiological Survey at 110 E. Hunter Avenue, Maywood, New Jersey (MJ022)**

ORNL/RASA-88/65; 9 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 110 E. Hunter Avenue, Maywood, New Jersey, was conducted during 1987. Following the removal of a small chunk of material showing elevated gamma exposure rates, all radionuclide concentrations and measurements conformed to DOE remedial action criteria. The slightly elevated radionuclide concentrations found in other soil samples were the result of naturally enhanced radioactivity characteristics of some environmental materials such as coal ash and were unrelated to operations at the MCW site. The survey data demonstrate that the property requires no further action on the part of DOE.

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**Results of the Radiological Survey at the National Community Bank, 113 Essex Street, Maywood, New Jersey (MJ021)**

ORNL/RASA-88/51; 9 pp. (September 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, the National Community Bank, 113 Essex Street, Maywood, New Jersey, was conducted during 1986. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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### Results of the Radiological Survey at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062)

ORNL/RASA-88/55; 11 pp. (July 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, Kennedy Park, Money and Sidney Streets, Lodi, New Jersey, was conducted during 1986 and 1987. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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### Results of the Radiological Survey at 88 East Central Avenue, Maywood, New Jersey (MJ037)

ORNL/RASA-88/80; 15 pp. (June 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 88 East Central Avenue, Maywood, New Jersey, was conducted during 1988. Results of the survey indicated radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria.

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### Results of the Radiological Survey at 142 West Central Avenue, Maywood, New Jersey (MJ041)

ORNL/RASA-88/84; 21 pp. (June 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak

Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 142 West Central Avenue, Maywood, New Jersey, was conducted during 1988. Results of the survey indicated scattered radiation or "shine" from a storage pile, located off the property, containing residual radioactive material. Lead-shielded measurements showed radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria.

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**Results of the Radiological Survey at West Hunter Avenue Firehall, Maywood, New Jersey (MJ027)**

ORNL/RASA-88/32; 7 pp. (March 1990)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the U.S. Department of Energy, a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, West Hunter Avenue Firehall, Maywood, New Jersey, was conducted during 1987.

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**Results of the Radiological Survey at 80 State Highway 46, Lodi, New Jersey (LJ092)**

ORNL/RASA-88/91; 15 pp. (March 1990)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. At the request of the U.S. Department of Energy, a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 80 State Highway 46, Lodi, New Jersey, was conducted during 1988.

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**Preliminary Site Survey Report of the Copperweld Steel Company, 4000 Mahoning Avenue NW, Warren, Ohio (CWO001)**

ORNL/RASA-90/2; 26 pp. (December 1990)

At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted investigative radiological surveys at the Copperweld Steel Company in 1988. The purpose of the surveys was to determine whether the property was contaminated with radioactive residues, principally uranium-238, derived from the former Manhattan Engineer District project. The surveys include gamma scans; direct and removable measurements of alpha, beta, and gamma radiation levels; and floor debris sampling for radionuclide analyses. Results of the survey demonstrated no radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program guidelines for radium, thorium, and uranium. The radionuclide distributions were not significantly different from normal background levels in the Ohio area.

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**Results of the Radiological Survey at 106 Columbia Lane, Lodi, New Jersey (LJ063)**

ORNL/RASA-88/56; 15 pp. (July 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 106 Columbia Lane, Lodi, New Jersey, was conducted during 1987. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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**Results of the Radiological Survey at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey (LJ066)**

ORNL/RASA-88/58; 19 pp. (August 1989)

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sand-like waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally thorium-232, derived from the MCW site. The survey typically includes direct measurement of the gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, the Firemen's Memorial Park and Fire Hall 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey, was conducted during 1987. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

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**An Aerial Radiological Survey of Technical Areas 2, 21, and 53 and Surroundings, Los Alamos National Laboratory, Los Alamos, New Mexico**

EGG-10617-1030; 30 pp. (September 1990)

An aerial radiological survey of the entire Los Alamos National Laboratory was flown in September 1982. The data from a part of the survey, Technical Areas 2, 21, and 53, are presented here along with pertinent data from an October 1975 survey of limited areas of Los Alamos. The data from Technical Area 15, another part of the survey, will be published in another report. Contour maps of the gamma survey data show some Cs-137 activity in Los Alamos Canyon as well as in DP Canyon beside TA-21. Some Be-7, Sb-124, and Co-58 apparently exist in the canyon immediately below the Los Alamos Meson Physics Facility ponds. Estimates on the Cs-137 inventory in the canyons range from 210 mCi to 1270 mCi. An exposure rate contour map at 1 meter above ground level was constructed from the gamma data and overlaid on an aerial photograph and map of the area. The terrestrial exposure rates ranged from 6 uR/h to about 18 uR/h.

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**Compilation of Selected Marine Radioecological Data for the Formerly Utilized Sites Remedial Action Program: Summaries of Available Radioecological Concentration Factors and Biological Half-Lives**

SAND-89-1585; 260 pp. (February 1991)

The Formerly Utilized Sites Remedial Action Program has updated an extensive objective concentration factor and biological half-life data base from the international marine radioecological literature. A microcomputer-based data management system has been implemented to provide statistical and graphic summaries of these data. The data base is constructed in a manner which allows subsets to be sorted using a number of interstudy variables such as organism category, tissue/organ category, geographic location (for in situ studies), and several laboratory-related conditions (e.g., exposure time and exposure concentrator). This report updates earlier reviews and provides summaries of the tabulated data. In addition to the concentration factor/biological half-life data base, we provide an outline of other published marine radioecological works. Our goal is to present these data in a form that enables those concerned with predictive assessment of radiation dose in the marine environment to make a more judicious selection of data for a given application.

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**FUSRAP - A Program of Progress**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 499-503) (1990)

Management problems are inherent on large environmental restoration projects. The Department of Energy's Formerly Utilized Sites Remedial Action Program (FUSRAP) uses a well documented, integrated management system to provide stability and control in a dynamic environment. This system is based on interrelated project controls and quality assurance principles. This paper describes management system development and uses FUSRAP as a model. This system has allowed for innovation and accomplishment within a structured framework. The foundation for FUSRAP's future progress is enhanced by its proven management system.

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**FUSRAP Management Control Systems**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 1-19) (April 1990)

This presentation explains the need for formal management control within the Formerly Utilized Site Remedial Action Program (FUSRAP) management system. According to a memorandum from Admiral James D. Watkins, Secretary of Energy, dated January 26, 1990, and quoted here, "Management systems [inside the Department of Energy] lack sufficient formality and discipline to implement effective ES&H [environmental safety and health] programs. Simply stated, the discipline and formality of our management systems must be improved." A formal management control system (1) provides continuity in work processes, (2) provides a training base, (3) clarifies a complex program, (4) provides a basis for improvement, (5) responds to the expectations of the new DOE organization, (6) is required by DOE orders and environmental regulations, and (7) prepares DOE contractors for internal audits and public scrutiny. The formal management control system developed by Bechtel for FUSRAP is outlined and illustrated.

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**Establishment of CERCLA Administrative Records for FUSRAP Sites**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 149-168) (April 1990)

The Formerly Utilized Sites Remedial Action Program (FUSRAP) established three Comprehensive Environmental Response, Compensation, and Liability Act administrative record files at local libraries in 1989 for sites in the St. Louis, Missouri, area and in Maywood, New Jersey. Documents have been identified for four additional administrative records for sites in New York, New Jersey, and Massachusetts. Excerpts from the posters are attached describing unique aspects and status of FUSRAP administrative records, showing the processes for establishing and maintaining them, listing the applicable regulations and requirements, and illustrating how relevant documents are identified in the FUSRAP communications register. The FUSRAP administrative record index for Maywood, New Jersey, and its associated introductory and explanatory material is also included.

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**Value Engineering and the CERCLA Process**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 433-440); Proceedings of the 1990 International Conference of the Society of American Value Engineers, Baltimore, MD, April 22-25, 1990, Vol. 25. Society of American Value Engineers, National Business Office, Northbrook, IL; (pp. 96-104) (1990)

This paper describes the method being used by the U.S. Department of Energy to incorporate requirements for a formal value engineering (VE) program into the Formerly Utilized Sites Remedial Action Program (FUSRAP), an environmental restoration program committed to the implementation of the Environmental Protection Agency remedial investigation and feasibility study process. It describes the approach to environmental remediation decision making followed by FUSRAP and summarizes the basic steps in the VE process. The two methods are then compared and their close similarities identified; the concept of the VE baseline study, a VE study for which cost savings cannot be quantified, is introduced.

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**Perceived Problems in Meeting EPA**

**Standards in FUSRAP Waste Disposal Facilities**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 543-548) (March 1989)

In 1987, the U.S. Environmental Protection Agency (EPA) issued a draft document, "Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments - Design, Construction, and Operation." The Formerly Utilized Sites Remedial Action Program (FUSRAP) is a U.S. Department of Energy (DOE) program to evaluate and remedy radioactive and chemical contamination conditions at sites across the nation. It is estimated that a small portion (5-10%) of the contaminated material being handled under this program is commingled with hazardous material to such an extent that the criteria of EPA standard 40 CFR 264 would be applicable. Application of design criteria developed for the disposal of hazardous materials in accordance with 40 CFR 264 to the DOE FUSRAP program is not a straightforward process because this program primarily involves radioactive waste. This paper includes a discussion of these issues. It also includes a discussion of the technical problems involved in incorporating Resource Conservation and Recovery Act features while meeting the requirements for long-term (1000-year) disposal facilities set forth in 40 CFR 192, "Standards for Protecting Against Uranium Mill Tailings." Finally, a solution is proposed for conforming to the requirements of both 40 CFR 192 and 40 CFR 264.

**411**

S.D. Liedle, Bechtel National, Inc., Oak Ridge, TN

**Demonstration of a Unique Decontamination Technique at the Elza Gate FUSRAP Site**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 241-255) (April 1990)

A demonstration was performed on decontaminating a radioactively contaminated concrete pad with a portable abrasive blasting system for the Elza Gate Site in Oak Ridge, Tennessee. Elza Gate is a Formerly Utilized Sites Remedial Action Program (FUSRAP) site. The system used a rotating blast wheel that scours the concrete surface with metal abrasive. The metal abrasive, pulverized concrete dust, and contaminants rebound into a separator chamber. The reusable metal abrasive is recycled and the pulverized media are removed to an integral dust collection system. The exhaust is filtered through a high-energy particulate air filter to minimize release of airborne contaminants. At the Elza Gate site, the system was set up to remove 1.6 mm of concrete layer per pass. A decontamination factor of about 0.5 was achieved with the first pass; two subsequent paases achieved decontamination factors of 0.3 and 0.2, respectively. This presentation is composed of a series of viewgraphs illustrating this unique concrete-decontamination demonstration.

**412**

S.D. Liedle and B.W. Clemens, Bechtel National, Inc., Oak Ridge, TN

**Environmental Compliance at U.S. Department of Energy FUSRAP Sites**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 58-60) (1988)

With the promulgation of the Superfund Amendments and Reauthorization Act (SARA), federal facilities were required to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in the same manner as any nongovernment entity. This situation presented challenges for the Department of Energy (DOE) and other federal agencies involved in remedial action work because there are many requirements under SARA that overlap other laws requiring DOE compliance [e.g., the National Environmental Policy Act (NEPA)]. This paper outlines the options developed to comply with CERCLA and NEPA as part of an active, multisite remedial action program.

413

E. McNamee, K. Nacy, and M. McDougall, Bechtel National, Inc., Oak Ridge, TN

**Innovations in Site Characterization Techniques**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 195-205) (April 1990)

The three techniques discussed in this poster session address innovations in characterization activities that provide cost savings, increase analytical abilities, and automate data collection methods. The iterative drilling process has been used successfully on several Formerly Utilized Sites Remedial Action Program (FUSRAP) sites and has saved several hundred thousand dollars. The PERALS system has provided FUSRAP with a quicker and more sensitive method for analyzing soil samples for Th-230. The USRADS system has also been used on FUSRAP and is one method that is being used to automate the data collection process.

414

M.H. Picel and J.M. Peterson, Argonne National Laboratory, Argonne, IL

**Strategies for Conducting Baseline Risk Assessments at FUSRAP Sites**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 367-391) (April 1990)

The main objectives of the Formerly Utilized Sites Remedial Action Program (FUSRAP) are to identify and evaluate radiological conditions at sites formerly utilized by Manhattan District/Atomic Energy Commission programs and to control and manage this contamination so that these sites can be certified for use without radiological restrictions to the extent practicable. There are currently 31 FUSRAP sites, several of which are on the National Priorities List (NPL). A remedial investigation/feasibility study (RI/FS) will be prepared for each of the NPL sites. FUSRAP risk assessments will address both human health and ecological risks and will carry out separate but parallel assessments for both chemical and radiological risks. The risk assessments activities within the RI/FS process consist of two components: (1) the Baseline Risk Assessment (BRA), which occurs during the RI, and (2) the risk assessment, which is performed during the FS to compare risk associated with each remedial alternative being considered. BRAs for FUSRAP sites will be prepared as stand-alone documents or will be folded into the RI report as a chapter, depending on the complexity of the assessment. BRAs at FUSRAP sites serve to analyze potential current and future adverse health effects caused by hazardous substance releases from a given site in the absence of actions to control or mitigate such releases. In addition, BRAs may aid in the prioritization of remedial actions and the development of cleanup criteria. As delineated by the Environmental Protection Agency, there are four basic steps to conducting risk assessment for a site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): (a) identification of the contaminants of concern, (b) exposure assessment, (c) toxicity assessment, and (d) risk characterization. This presentation explores FUSRAP guidelines for compliance with CERCLA BRAs.

415

R.E. Rodriguez, D.A. Witt, W.D. Cottrell, and R.F. Carrier, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of Mobile Scanning Activities in St. Louis, Missouri**

ORNL/RASA-90/7; 9 pp. (June 1991)

Between 1942 and 1966, the Mallinckrodt Chemical Works operated four plants in St. Louis, Missouri, for the Manhattan Engineer District and the Atomic Energy Commission (AEC). A variety of production processes using uranium- and radium-bearing ore materials were performed at the plants. It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such sites or facilities comply with current DOE guidelines. Guidelines for release and use of such sites have become more stringent as research has provided more information since previous cleanups. The Formerly Utilized Sites Remedial Action Program (FUSRAP) was established as part of that effort to confirm the closeout status of facilities under contract to agencies preceding DOE during early nuclear energy development. Under FUSRAP, the Mallinckrodt properties have been previously investigated to determine the extent of on-site radiological contamination. At the request of DOE, Oak Ridge National Laboratory in May 1990 conducted a survey, of public roadways and suspected haul routes between the Mallinckrodt plant and storage sites in St. Louis to ensure that no residual radioactive materials were conveyed off site. A mobile gamma scanning van with an on-board computer system was used to identify possible anomalies. Suspect areas are those displaying measurements deviating from gamma exposure rates identified as typical for radiologically unenhanced areas in the vicinity of the areas of interest. The instrumentation highlighted three anomaly locations each of which measured less than 1 sq m in size. None of the slightly elevated radiation levels originated from material associated with former AEC-related processing operations in the area. The anomalies resulted from elevated concentrations of radionuclides present in phosphate fertilizers, increased thorium in road-base gravel, and emanations from the radioactive storage site near the Latty Avenue airport.

**416**
R.E. Swaja and W.D. Cottrell, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN

**Results of the Radiological Survey at the Granite City Steel Facility, Granite City, Illinois**

ORNL/RASA-89/10; 40 pp. (July 1990)

In the late 1950s and early 1960s, uranium ingots were x-rayed for the Atomic Energy Commission at the South Plant facility of the Granite City Steel Company, Granite City, Illinois. The x-ray equipment is still housed in a building on the southern end of the property. At the time of the survey, neither the equipment nor the building had been used for some time. It is the policy of the U.S. Department of Energy to verify that such sites are in compliance with current federal guidelines. Because documentation establishing the current radiological condition of the property is unavailable, a radiological survey was conducted by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory in March 1989. The survey included (1) measurement of gamma exposure rates, both indoors and outdoors; (2) collection and radionuclide analysis of soil and debris samples; and (3) measurements to determine alpha and beta-gamma surface contamination.

**417**
U.S. Department of Energy, Assistant Secretary for Environment, Safety, and Health, Washington, DC

**Environmental Audit of the Maywood Site: Formerly Utilized Sites Remedial Action Program, Maywood Interim Storage Site Vicinity Properties**

DOE/EH-0163P; 237 pp. (December 1990)

This report presents the results of the environmental audit of the Maywood Site managed by the Formerly Utilized Sites Remedial Action Program (FUSRAP). The audit was carried out from November 7 through 16, 1990. The audit team found the overall technical competence and knowledge of the management and staff of both DOE and Bechtel National, Inc. (BNI) to be excellent. In particular, there was excellent knowledge of federal, state, and local environmental regulations, as well as analysis for applicability of these regulations to FUSRAP. Project management of the Maywood Site is also excellent. BNI and DOE project staff have made frequent contact with members of the community, and all removal actions and remedial investigation activities have been planned, scheduled, and accomplished with competence and attention to total quality principles. To date, all actions taken for the Maywood Site cleanup have been completed ahead of schedule and on or under budget. The weaknesses noted include self-assessment efforts by DOE, failure to fully implement DOE order requirements throughout the program, and some discrepancies in formally documenting and reviewing procedures.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**DOE Seeks Public Comment on Proposed Cleanup at Elza Gate Site**

DOE News (901206):1-2 (December 6, 1990)

In this press release/public announcement, the Oak Ridge Operations office of the U.S. Department of Energy (DOE) announces for public comment an engineering evaluation/cost analysis (EE/CA) for cleanup of a portion of the Elza Gate Site in Oak Ridge. The Elza Gate Site, now known as Melton Lake Industrial Park, is located on the east end of Oak Ridge. Contamination present in the soil under one of five on-site concrete pads, referred to as Pad 1, includes uranium, radium, and thorium. The EE/CA summarizes the analysis of cleanup alternatives and rationale for DOE's remedial action preference for Pad 1. Options include the removal of the contaminated soil by either excavation or treatment, followed by an interim storage method. Additional action will be required to remediate the remainder of the site. This action will be the subject of a separate EE/CA to be published in Spring 1991. The EE/CA for the Pad 1 cleanup is available for public review at the DOE Information Resource Center, temporarily located at Lee Wan & Associates, 120 Jefferson Circle, Suite 100, Oak Ridge, Tennessee 37380, phone (615) 483-9870.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**DOE Selects Firms for Environmental Cleanup and Compliance**

DOE News (910404):1-2 (April 4, 1991)

This news release announces selection by the U.S. Department of Energy (DOE) Oak Ridge Operation Office of two firms to negotiate contracts for environmental cleanup and compliance work. Bechtel National, Inc. (BNI) was selected to manage remedial action for the DOE Formerly Utilized Sites Remedial Action Program (FUSRAP), and Science Applications International Corporation (SAIC) has been selected for environmental compliance support for the FUSRAP program and for similar activities at DOE gaseous diffusion plants in Portsmouth, Ohio, and Paducah, Kentucky. Under FUSRAP, DOE conducts remedial actions to remove, reduce, or stabilize low-level radioactivity remaining at sites used in the early days of the Manhattan Project. Most of the FUSRAP sites are commercial properties that were once used for research or processing and/or storage of uranium and thorium. To date, Congress has assigned DOE the responsibility for cleaning up 33 sites in 13 states. These efforts are described in each annual update of the DOE Environmental Restoration and Waste Management Five-Year Plan. The gaseous diffusion plants enrich uranium for use as fuel for commercial nuclear power reactors and for nuclear propulsion for the U.S. Navy. Since 1981, BNI has held the FUSRAP contract and DOE has retained the project management responsibility and a portion of the environmental compliance functions. DOE decided last year to split the existing contract into separate contracts for management and environmental support. BNI will continue to operate from its Oak Ridge office and will implement the contract using local subcontractors in the areas of the sites to the extent feasible. Both contracts are cost-plus-fixed-fee contracts. The BNI contract is for a 5-year base period with one 2-year option period. DOE estimates it to be worth \$465 million through its length. The SAIC contract for a 3-year base period with two 2-year options is valued at approximately \$28 million over its lifetime.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**DOE Completes First Phase of Environmental Restoration at Elza Gate Site**

DOE News (910426):1-2 (April 26, 1991)

This news release announces completion of the first phase of the project to remove residual radioactive contamination from a building and the grounds at the Elza Gate Site in Oak Ridge, Tennessee. Phase One of the cleanup, managed by Bechtel National, Inc., included removal of contaminated soil and concrete from Pad 1 within the building.

421
U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**DOE Seeks Public Comment on Proposed Cleanup at Elza Gate Site**

DOE News (910627):1-2 (June 27, 1991)

This news release announces the U.S. Department of Energy (DOE) public notice requesting comment on an engineering evaluation/cost analysis (EE/CA) for the final phase of cleanup of the Elza Gate Site. The cleanup is part of the DOE Formerly Utilized Sites Remedial Action Program, which presently includes 33 sites in 13 states that were used in the early days of the Manhattan Project. The Elza Gate site, now known as Melton Lake Industrial Park, is in the east end of Oak Ridge, Tennessee. Contamination present on-site includes uranium, radium, thorium, and polychlorinated biphenyls. The site originally consisted of five warehouses and possibly other small structures that were used to store high-grade uranium ore and processing residues as part of the government's early nuclear energy program. On April 26, 1991, the DOE Oak Ridge field office announced the completion of Phase 1, the removal of contaminated soil and concrete from an area referred to as Pad 1. The current EE/CA summarizes the analysis of cleanup alternatives and the choice of remedial action for the removal of the remaining contaminated material.

422
U.S. Department of Energy, Washington, DC

**Floodplain Notification for Proposed Removal Action at Properties Located in Hazelwood and Berkeley, MO**

Federal Register 56(121):28750 (June 24, 1991)

The U.S. Department of Energy (DOE) proposes to remove radioactively contaminated materials from properties in the vicinity of the Hazelwood Interim Storage Site (HISS) and to stabilize and control these materials at HISS. HISS is located in northern St. Louis County, approximately 3 km (2 mi) north of Lambert-St. Louis International Airport. DOE proposes to conduct this removal under section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act and pursuant to 40 CFR 300.415b(2). The removal of radioactively contaminated material from residential, commercial, and municipal properties would result in storage of the contaminated material at HISS. The action is necessary to remove contaminated soil that exceeds current DOE criteria for residual radioactivity established for the Formerly Utilized Sites Remedial Action Program. DOE has determined that the proposed storage activities would involve activities within the floodplain of Coldwater Creek. In accordance with DOE regulations, DOE will prepare a floodplain assessment to be incorporated in the Engineering Evaluation/Cost Analysis-Environmental Assessment and publish a statement of findings.

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S.G. Wilkinson, N.C. Ring, and B.C. McConnel, Analysas Corporation, Oak Ridge, TN; Bechtel National, Inc., Oak Ridge, TN

**Sheffield Brook - A Case Study**

CONF-881054 (Vol. 4); Proceedings of the 1988 DOE Model Conference, Oak Ridge, TN, October 3-7, 1988, Vol. 4, 374 pp.; (pp. 1103-1114) (1988)

The U.S. Department of Energy is conducting remedial action at various radioactively contaminated sites with Bechtel National, Inc., as its project management contractor. At the Wayne Interim Storage Site in New Jersey, remedial activities have included cleanup of an active stream contaminated with low-level radioactivity and local, interim storage of the waste. Special requirements associated with these activities included obtaining permits from the U.S. Army Corps of Engineers and the New Jersey Department of Environmental Protection, restoration of wetlands, control of water and sediments, and prevention of contaminant migration during remedial action.

# FACILITIES CONTAMINATED WITH NATURAL RADIOACTIVITY

424

J.K. Archibald, C.L. Jacobson, J.E. Virgona, and J.A. Brink, UNC Geotech, Inc., Grand Junction, CO; U.S. Department of Energy, Grand Junction Project Office, Grand Junction, CO; U.S. Environmental Protection Agency, Denver, CO

**Planning for the Offsite Disposal of Waste Generated in the Remediation of the Denver Radium Superfund Site**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 137-141) (March 1989)

In this paper, plans for the off-site disposal of waste from the Denver Radium Superfund Site are discussed. The Denver Radium Site consists of over forty radium-contaminated properties in metropolitan Denver. These properties were contaminated from the production of radium during the early twentieth century. The properties have housed a variety of activities; current uses now vary from no use (empty land) to warehouses to retail and manufacturing facilities. The remedial action project currently under way at the Denver Radium Site is one of the largest in the United States where the selected remedy is off-site disposal. The U.S. Department of Energy Grand Junction Project Office and its contractor, UNC Geotech, are performing remedial action on these properties under an Interagency Agreement with the U.S. Environmental Protection Agency (EPA). One of the major challenges of the remedial action is planning for the off-site disposal of over 250,000 cu yd of contaminated soils and building materials that are being excavated during the remedial process. This is a significant challenge because of the lack of specific requirements regarding the disposal of this material, the quantity of the material, possible presence of Resource Conservation and Recovery Act (RCRA) or Toxic Substances Control Act materials, and public concern about the shipment over public highways. The waste generated from this remedial action is classified by EPA and the Utah Department of Health as naturally occurring radioactive material (NORM). However, the Rocky Mountain Low-Level Radioactive Waste Compact and the Colorado Department of Health consider the material to be low-level radioactive waste. There is at least one facility that has a state license for disposal of NORM wastes and a secondary facility may become available. The volume of waste material to be removed from the Denver Radium Site is approximately two and one half times the volume of low-level waste generated in the United States annually and over twenty times that generated by the Rocky Mountain Compact annually. Because of the tremendous volume of waste being generated in this remedial action, a plan for cost-effective handling of this material is essential. In addition, concern over the use of public transportation routes must be addressed. It is not anticipated that a site will be found that can receive both NORM waste and waste generated under RCRA. Therefore, it is necessary to develop a waste certification plan that ensures that each shipment meets the waste acceptance criteria for the facility that it will be shipped to. In addition, it is necessary to develop plans for managing waste that does not meet the waste acceptance criteria of the primary disposal facility. In summary, planning for the off-site disposal of waste from the Denver Radium Site is a significant challenge of great interest to the waste management community at large and those involved with remedial action at radioactive waste sites, in particular.

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R.L. Huston, Chem-Nuclear Systems, Inc., Columbia, SC

**Post Remedial Action Report, Lansdowne Radioactive Residence Complex, Dismantlement/Removal Project - Volume 2: Contractor Operations**

AD-A-230430/1 (Vol. 2); CENAB-CO-HTW/90-01/EPA(S)(Vol.2); 151 pp. (June 1990)

The operations closeout report was prepared to document the successful completion of final remediation of the U.S. Environmental Protection Agency Superfund cleanup of a radium-contaminated duplex residence and associated properties located in Lansdowne,

Pennsylvania. This report addresses the efforts to perform the residence dismantling, soil remediation, and restoration of the site to a useable condition. It covers the period from contract award through all stages of project conduct, including plan preparation, mobilization, initial site preparation, site clearing and security arrangements, dismantlement of structures, excavation of contaminated soils, transportation and disposal of radioactively contaminated and hazardous wastes, final verification of compliance to release criteria, site restoration, and demobilization. Pertinent data such as final waste volumes, results of testing, and site configuration prior to, during, and post remediation are included. The site organizational structure, individual responsibilities, and subcontractors utilized are provided.

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C.L. Jacobson, UNC Geotech, Inc., Grand Junction, CO

**Sampling and Transportation of Denver Radium Superfund Site Waste**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 21-28) (April 1990)

Contaminated soil from the Denver Radium Superfund Site is being shipped to a licensed disposal facility in Utah. Obtaining the waste transportation and disposal services was very time consuming and it complicated the remedial action scheduling. This paper discusses the sampling and transportation of the waste. Residues from radium processing at the National Radium Institute in the early part of this century and from other radium processors through the 1920s left many discarded residues that were subsequently used as fill or cover or mixed with other building materials. The U.S. Environmental Protection Agency (EPA) and the state of Colorado identified 31 properties as having low-level radioactive contamination from these residues, collectively called the Denver Radium Site. The U.S. Department of Energy Grand Junction Projects Office conducted remedial design and remedial action at the site for EPA. The Bureau of Reclamation manages the transportation and disposal of the wastes. EPA and the Utah Department of Health use the term naturally occurring radioactive material (NORM) for the waste, because the radioactive species are left over from ore processing and are not reactor-produced. The Rocky Mountain Low-Level Radioactive Waste Compact and the Colorado Department of Health consider the wastes to be low-level radioactive waste, although it is not regulated as such by the Nuclear Regulatory Commission. Transportation of the waste began in August 1989 and will continue into 1993.

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L. Jensen, Argonne National Laboratory, Argonne, IL

**NORM Impacts of Air Stripping and Soil Gas Evacuations Used for Chemical Cleanups**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 129-146) (April 1990)

This presentation focuses on the regulatory complications, health hazards, and radiation protection concerns of naturally occurring radioactive material (NORM) occurring in fundamentally nonradiological remediation processes. Generally, it is not recognized that NORM co-contaminants may be removed simultaneously during commonly used pump-and-treat techniques for the removal of volatiles in soil or groundwater. NORM may also be coincidentally removed during the removal of nonvolatiles by other techniques. The cleanup media used in the removal processes are usually successful at scavenging these radionuclides as well. As a result, radiological risks may be added to the chemical risks of the removal work. When long-lived radionuclides are collected, waste disposal may be much more difficult because such wastes are classified as mixed wastes. NORM co-contamination raises concerns over the health hazards of contaminant exposures to workers and the public. The individual states regulate NORM, because it is not subject to the Atomic Energy Act; this may expand the list of applicable or relevant and appropriate requirements (ARARs) related to remediation. Three remediation techniques may be impacted by NORM co-contamination: (1) soil gas evacuation, (2) air stripping, and (3) ion exchange resin treatment. In soil gas evacuation and air stripping, the NORM contaminants Rn-220 and Rn-222 are pumped out with the chemical contaminants, then are either released with them or trapped on the collection media. During ion exchange resin treatment, the NORM contaminants Ra-226, Ra-228, and U-238 are concentrated on the collection media.

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E.R. Landa, U.S. Geological Survey, Water Resources Division, Reston, VA

**Geochemical and Radiological Characterization of Soils from Former Radium Processing Sites**

Health Physics 46(2):385-394 (1983)

Soil Samples were collected from former radium processing sites in Denver, Colorado, and East Orange, New Jersey. Particle-size separations and radiochemical analyses of selected samples showed that while the greatest contents of both Ra-226 and uranium were generally found in the finest fraction, the pattern was not always of progressive increase in radionuclide content with decreasing particle size. Leaching tests on these samples showed a large portion of the Ra-226 and uranium to be soluble in dilute hydrochloric acid. Radon-emanation coefficients measured for bulk samples of contaminated soil were about 20%. Recovery of residual uranium and vanadium as an adjunct to any remedial action program appears unlikely because of economic constraints.

429
Marshall, Macklin, and Monaghan Limited, Don Mills, Ontario, Canada

**Assessment of Proposed Remedial Action Plans for Hamilton Harbour: Final Report**

GRAI9101; 294 pp. (1988)

This report documents a study to evaluate and integrate the relevant biological, chemical, social, and economic data and information to determine a cost/benefit framework for the Hamilton Harbour remedial action plan. The study identifies the remedial and mitigative measures for achieving the proposed uses of the Harbour and develops a framework for valuing the benefits associated with the resulting improvements in water quality and recreational activities. The preferred end use is that of a warm water fishery, plus recreational activities, shipping and navigation, wastewater receiving body, and industrial water supply.

430
D.W. Moeller, Harvard School of Public Health, Boston, MA

**Natural Radiation in the Environment**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. xix-xxxiii) (1990)

The author discusses natural radiation in the environment. He outlines the external sources of exposure (cosmic and terrestrial) and the internal sources (ingestion and inhalation). He states that a clear understanding of these sources and their impacts is necessary to properly evaluate both environmental and human radiation exposure.

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M. Nimmagadda and C. Yu, Argonne National Laboratory, Environmental Assessment and Information Sciences Division, Argonne, IL

**Preliminary Radiation Dose Assessment for the Palmerton Ore Storage Site, Palmerton, Pennsylvania**

ANL/EAIS/TM-42; 33 pp. (February 1991)

Potential maximum radiation doses rates were calculated for the Palmerton ore storage site in Palmerton, Pennsylvania. The RESRAD computer code, which implements the methodology described in the U.S. Department of Energy's manual for establishing residual radioactive material guidelines, was used in this evaluation. Four potential scenarios were considered for the Palmerton ore storage site. Two scenarios were developed on the basis of industrial use of the site, and two were developed on the basis of residential use of the site. The scenarios also vary with regard to time spent at the site, sources of food consumed, and source terms. The RESRAD code was used to analyze potential radiation doses from three exposure pathways. The results indicate that the basic dose limit of 100 mrem/yr would not be exceeded in Scenarios A (industrial use and hot spot), B (industrial use and homogenous contamination), and C (residential use and homogenous contamination), but would be exceeded in Scenario D (residential use and hot spot). The potential maximum dose rates for Scenarios A, B, C, and D are 1.0 mrem/yr, 0.66 mrem/yr, and 360 mrem/yr, respectively.

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C.M. Sholeen and W.J. Munyon, Argonne National Laboratory, Environment, Safety and Health Division, Argonne, IL

**Post Remedial Action Report, Lansdowne Radioactive Residence Complex, Dismantlement/Removal Project - Volume 4: Radiological Oversight and Certification**

ANL-ESH/TS-90/010 (Vol. 4); CENAB-CO-HTW/90-01/EPA(S)(Vol.4);342 pp. (June 1990)

During the period 1924-1944, a University of Pennsylvania physics professor was engaged in the commercial production of radium sources for medical use. As a result of the radium enrichment activities, the entire residence, the surrounding land, and the adjoining residence became contaminated. In August 1985, this site was officially added to the U.S. Environmental Protection Agency list of hazardous sites targeted for cleanup (Superfund). On-site radiological overview was provided to the U.S. Army Corps of Engineers for the remedial activities. The oversight included radiological surveying, laundry/waste water sampling, air sampling, and logging of contamination in the soil. Additional oversight responsibility included verification that the soil remaining on the site, adjacent to the site, under the sewer line, and backfill soil were below the cleanup criterion of 5 pCi/g above the natural Ra-226 background level of 1.5 pCi/g. The exposure rate measurements from the restored site ranged from 8 to 11 mR/hr, typical of background levels in this area. This report provides documentation that the cleanup criterion of 5 pCi/g of Ra-226 above background has been met.

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P. Trujillo, Chem-Nuclear Systems, Inc., Columbia, SC

**Post Remedial Action Report, Lansdowne Radioactive Residence Complex, Dismantlement/Removal Project - Volume 3: Radiological Closeout Documentation**

AD-A-230431/9 (Vol. 3); CENAB-CO-HTW/90-01/EPA(S)(Vol.3);306 pp. (June 1990)

The radiological closeout report was prepared to document the successful completion of final remediation of a radium-contaminated duplex residence and associated properties located in Lansdowne, Pennsylvania. This report addresses the efforts to provide radiological coverage of the project from initial award through final verification. The report includes plan preparation, training, personnel monitoring, air sampling, environmental compliance, radiological surveys, verification of cleanup to allowable limits, radiological techniques, soil sampling and verification methods utilized. The report is formatted by major task, with associated data provided for each major task or division of work.

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G. Vandergaast, D. Moffett, and B.E. Lawrence, Eldorado Nuclear Limited, Ottawa, Ontario, Canada; MacLarentech, Inc., Toronto, Ontario, Canada

**Cleanup Around an Old Waste Site - A Success Story**

INIS-mf-12827; CONF-880662; Proceedings of the 28th Annual Conference of the Canadian Nuclear Association and the Ninth Annual Conference of the Canadian Nuclear Society, Winnipeg, Canada, June 12-15, 1988, 488 pp.; (pp. 151-156) (1988)

Contaminated soil (about 42,500 sq m) was removed from off-site areas around an old, low-level radioactive waste site near Port Hope, Ontario. The cleanup was done by means of conventional excavation equipment to criteria developed by Eldorado which are specific to the land use around the company's waste management facility. These cleanup criteria were based on exposure analyses carried out for critical receptors in two different scenarios. The excavated soils, involving eight different landowners, were placed on the original burial area of the waste management facility. Measures were also undertaken to stabilize the soils brought on-site and to ensure that there would be no subsequent recontamination of the off-site areas.

**435**
W.C. Wickboldt, U.S. Army Corps of Engineers, North Atlantic Construction Division, Baltimore, MD

**Post Remedial Action Report, Lansdowne Radioactive Residence Complex, Dismantlement/Removal Project - Volume 1: Government Operations**

AD-A-230429/3 (Vol. 1); CENAB-CO-HTW/90-01/EPA(S) (Vol. 1); 289 pp. (June 1990)

The Lansdowne radioactive residence complex and 250 ft of municipal sewer became contaminated by radium processing during the period 1924-1944. Cleanup of the site necessitated the removal of contaminated rubble generated by building and sewer dismantlement and of radioactive soil that became contaminated because waste products from the radium processing activity were buried in the ground around the site. Prior to remediation, radium levels in the soil ranged as high as 700 pCi/g; following remediation, radium levels had been reduced to no greater than 5 pCi/g above the local background of 2.5 pCi/g. Following removal of contamination, the site was backfilled to near original grade and restored as a grassed lot. A replacement sewer line was constructed.

# URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM

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**A Bill for the Uranium Mill Tailings Remedial Action Amendments Act of 1987**

U.S. Senate Bill S-1991, Introduced in the Senate of the United States, One Hundredth Congress, Second Session, September 23, 1987; 3 pp. (1987)

Senate Bill S-1991 is a bill for the Uranium Mill Tailings Remedial Action Amendments Act of 1987. The Act proposes the application of National Environmental Policy Act (NEPA) provisions to radioactive waste storage sites selected for permanent transfer of lands until they are actually transferred.

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**A Bill to Amend the Uranium Mill Tailings Radiation Control Act of 1978**

U.S. House Resolution HR-4591, Introduced in the House of Representatives, One Hundredth Congress, Second Session, May 12, 1988; 4 pp. (1988)

The bill House Resolution 4591 amends the Uranium Mill Tailings Radiation Control Act of 1978. This bill sets forth lands that the Secretary of the Interior may transfer to the U.S. Department of Energy in the vicinity of the processing sites in certain counties in Arizona, Colorado, Idaho, North Dakota, Utah, and Wyoming. The process for acquisition of land near processing sites is defined. The term of enforcement of this act is set to terminate on September 30, 1994, except for those activities related to remedial action with respect to groundwater restoration. The bill was referred jointly to the Committees on Interior and Insular Affairs and Energy and Commerce.

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S.R. Abt, J.D. Nelson, T.L. Johnson, and E.F. Hawkins, Colorado State University, Fort Collins, CO; U.S. Nuclear Regulatory Commission, Rockville, MD; U.S. Nuclear Regulatory Commission, Denver, CO

**Cap Stabilization for Reclaimed Uranium Sites**

Journal of Energy Engineering 115(3):109-119 (December 1989)

The reclamation and stabilization of uranium mill tailings sites requires engineering designs to protect against the disruption of tailings and the potential release of radioactive materials. The reclamation design is to be effective for 200-1000 years. This paper presents recently developed or refined techniques and methodologies used to evaluate uranium-tailings-reclamation plans designed to provide long-term stability against failure modes. Specific cap-design aspects presented include design flood selection, influence of fluvial geomorphology on-site stabilization, stable slope prediction, slope stabilization using riprap, and riprap selection relative to rock quality and durability. Design relationships are presented for estimating flow through riprap, sizing riprap, and estimating riprap flow resistance for overtopping conditions. Guidelines for riprap-layer thickness and gradation are presented. A riprap-rating procedure for estimating rock quality an \ durability is also presented.

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A. Bachrach, J. Hoopes, D. Morycz, M.J. Bone, S. Cox, D. Jones, D.J. Lechel, C. Meyer, M. Nelson, R.C. Peel, R. Portillo, L. Rogers, B. Taber, P. Zelle, and G. Rice, Jacobs Engineering Group, Inc., Pasadena, CA; Roy F. Weston Company, Inc., Washington, DC; Sergent, Hauskins and Beckwith Geotechnical Engineers, Washington, DC

**Environmental Assessment of Remedial Action at the Gunnison Uranium Mill Tailings Site, Gunnison, Colorado**

DOE/UMTRA-91005826; 151 pp. (December 1984)

This document assesses and compares the environmental impacts of various alternatives for remedial action at the Gunnison uranium mill tailings site located 0.5 miles south of Gunnison, Colorado. The site covers 56 acres and contains 35 acres of tailings, 2 of the original mill buildings, and a water tower. The Uranium Mill Tailings Radiation Control of Act of 1978, Public Law 95-604, authorizes the U.S. Department of Energy to clean up the site to reduce the potential health impacts associated with the residual radioactive materials remaining at the site and at associated (vicinity) properties off the site. The U.S. Environmental Protection Agency promulgated standards for the remedial actions (40 CFR 192). Remedial actions must be performed in accordance with these standards and with the concurrence of the Nuclear Regulatory Commission. Four alternatives have been addressed in this document. The first alternative is to consolidate the tailings and associated contaminated soils into a recontoured pile on the southern portion of the existing site. A radon barrier of silty clay would be constructed over the pile and various erosion control measures would be taken to ensure the long-term integrity of the pile. Two other alternatives which involve moving the tailings to new locations are assessed in this document. These alternatives generally involve greater short-term impacts and are more costly, but would result in the tailings being stabilized in a location farther from the city of Gunnison. The no-action alternative is also assessed.

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S. Beranich, N. Berger, D. Bierley, T.M. Bond, C. Burt, J.A. Caldwell, V.A. Dery, A. Dutcher, W.A. Glover, R.J. Heydenburg, N.B. Larson, G. Lindsey, J.M. Longley, J.B. Millard, M. Miller, R.C. Peel, C.H. Persson-Reeves, F.B. Titus, and L. Wagner, Roy F. Weston Company, Inc., Washington, DC

**Environmental Assessment of Remedial Action at the Inactive Uraniferous Lignite Processing Sites at Belfield and Bowman, North Dakota**

DOE/EA-0346; 82 pp. (September 1989)

Under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), cleanup of the Belfield and Bowman, North Dakota, uraniferous lignite-processing sites was initiated to reduce the potential health impacts associated with the residual radioactive materials remaining at these sites. Remedial action at these sites must be performed in accordance with the U.S. Environmental Protection Agency (EPA) standards promulgated for the remedial action and with the concurrence of the U.S. Nuclear Regulatory Commission and the state of North Dakota. The inactive Belfield uraniferous lignite processing site is one mile southeast of Belfield, North Dakota. The inactive Bowman uraniferous lignite-processing site at the former town of Griffin is seven miles northwest of Bowman, North Dakota and 65 road miles south of Belfield. Lignite ash from the processing operations has contaminated the soils over the entire 10.7-acre designated Belfield site and the entire 12.1-acre designated Bowman site. Dispersion of the ash has contaminated an additional 20.6 acres surrounding the Belfield processing site and an additional 59.2 acres surrounding the Bowman processing site. The proposed remedial action is to relocate the contaminated materials at the Belfield processing site to the Bowman processing/disposal site for codisposal with the Bowman contaminated soils. The environmental impacts assessed in this environmental assessment were evaluated for the proposed remedial action and the no action alternative, and demonstrate that the proposed action would not significantly affect the quality of the human environment and would be performed in compliance with applicable environmental laws. The no action alternative would not be consistent with the intent of Public Law 95-604 and would not comply with EPA standards.

**441**

D. Bierley, Roy F. Weston Company, Inc., Albuquerque, NM

**Regulatory Compliance and the UMTRA Project: A Look at Three Sites**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 133-135) (1988)

In 1978, Congress passed the Uranium Mill Tailings Radiation Control Act (Public Law 95-604), establishing the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project. This project is charged with the cleanup and stabilization of 24 inactive uranium mill sites in 10 states, primarily in the

western United States. Each of these sites have unique regulatory issues. This paper discusses and compares the various regulatory issues associated with the Durango, Colorado; Ambrosia Lake, New Mexico; and the Riverton, Wyoming, UMTRA Project sites.

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D. Bierley, Roy F. Weston Company, Inc., Albuquerque, NM

**UMTRA Project Cleanups Versus RCRA Closures and Corrective Actions**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 586-610) (April 1990)

The U.S. Department of Energy Uranium Mill Tailings Remedial Action (UMTRA) Project has its own congressionally mandated regulations concerning the disposal and cleanup of uranium mill tailings and associated contamination. The Resource Conservation and Recovery Act (RCRA) and its amendments regulate designated hazardous wastes from generation through disposal. The UMTRA Project remedial activities have some similarities to the RCRA closure and corrective action programs associated with RCRA. This presentation outlines those similarities and highlights the differences in the two programs.

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M. Bimal, Roy F. Weston Company, Inc., Albuquerque, NM

**Geochemistry of Contaminant Migration: Examples from Uranium Mill Tailing Studies**

CONF-8910195; Proceedings of the American Association of Petroleum Geologists Rocky Mountain Section Meeting, Albuquerque, NM, October 1-4, 1989; American Association of Petroleum Geologists Bulletin 73(9):1147-1148 (September 1989)

Detailed core description data on the visual redox boundaries, mineralogy, and hydrostratigraphy constitute the foundation for geochemical investigations of contaminant migration from waste dumps. The geochemical investigations first establish the site-specific list of regulated contaminants requiring remediation. This list is developed through systematic sampling and analysis of groundwater for the organic and inorganic constituents currently regulated by the Environmental Protection Agency. The geochemical data needed to understand the distribution of present contaminant plumes and to predict the potential for their future migration include careful on-site measurements of unstable parameters, including pH and certain redox couples, alkalinity, specific conductance, and temperature and laboratory measurements of major and minor elements including the contaminants. These analytical data are then used to predict the precipitation-dissolution and adsorption-desorption states of the contaminants, employing numerical codes such as WATEQFC, PHREEQE, and MINTEQ. Conclusions regarding contaminant migration are then based on the results of description and predictions by numerical codes. This presentation gives examples of the integrated geochemical investigations on contaminant migration in the aquifers below tailing dumps resulting from processing uranium ores from the Colorado Plateau and the Powder River basin.

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M.J. Bone, Roy F. Weston Company, Inc., Albuquerque, NM

**Design Considerations for Stabilization of Inactive Uranium Mill Tailings Piles**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 735-739) (1986)

The U.S. Department of Energy oversees the Uranium Mill Tailings Remedial Action (UMTRA) Project. This involves remedial action work at 24 inactive uranium mill tailings piles in

10 states. The principal objective of the UMTRA Project is to provide engineering designs that meet the long-term containment and stability requirements of U.S. Environmental Protection Agency standards. This paper focuses on engineering designs for stabilizing piles of mill tailings at UMTRA sites.

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B.M. Bunger and C.E. Foutes, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

**Economic Evaluation of Remanded Clean Air Act Standards for Uranium Mill Tailings Piles**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 143-147) (March 1989)

In 1986 the Environmental Protection Agency (EPA), under authority of the Clean Air Act (CAA), established standards for controlling radon emissions from uranium mill tailing piles. As a result of a court decision on a related standard, EPA voluntarily remanded all of its CAA standards for radionuclides in December 1987, including the 1986 standards for Uranium Mill Tailings. EPA currently plans to promulgate final CAA standards for uranium mill tailing piles by August 31, 1989. Three separate standards are under consideration. This paper discusses the economics associated with the various regulatory alternatives. The numbers presented are abstracted from the EPA Background Information Document on the forthcoming CAA standards. The first section of the paper deals with regulatory economics and provides some background on the way EPA addresses economics under the CAA. The second section is a brief discussion of the uranium milling industry. The third section discusses the benefit cost analysis for inactive and licensed mill tailing piles and presents some of its more important findings. Lastly, a summary of the impacts of various combinations of possible regulations is presented.

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J.A. Caldwell and L.M. Phyfe, Jacobs Engineering Group, Inc., Albuquerque, NM

**Seismic Stability Analysis of Disposal Cells on the Uranium Mill Tailings Remedial Action Project**

DOE/OR/21548-197; Weldon Spring Site Remedial Action Project, Proceedings of the Geosciences Workshop, O'Fallon, MO, February 21, 1991, 361 pp.; (pp. 309-330) (February 1991)

The U.S. Department of Energy is remediating 24 inactive mill tailings piles in 10 states. The disposal cells at these mill tailings sites are designed to remain stable during a maximum credible earthquake. To do this, the stability of foundation soils is evaluated by comparing the density and strength of the soils with earthquake-induced forces. The seismic stability of the disposal cell perimeter embankments is assessed, using either pseudostatic or full dynamic analysis.

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J.A. Caldwell and C.C. Reith, Jacobs Engineering Group, Inc., Albuquerque, NM

**Cover Design for Uranium Mill Tailings Piles - A Standard for the Future**

Mining & Mineral Processing Wastes, Proceedings of the Western Regional Symposium, Berkeley, CA, May 30-June 1, 1990. Society for Mining, Metallurgy & Exploration, Inc., Littleton, CO; (pp. 213-220) (1990)

This paper describes the covers used to stabilize inactive uranium mill tailing piles and the recent geotechnical advances incorporated into the design of such covers. Although generally too conservative and expensive for use in conventional mine reclamation projects, the covers designed and constructed to remediate inactive uranium mill tailing piles incorporate most or all of the components required to provide long-term erosion resistance and groundwater protection in reclaiming a mine waste disposal facility. This paper evaluates the applicability of established and new technical approaches for uranium mill tailings stabilization to the broader field of general mine reclamation.

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J.A. Caldwell and T.A. Shepherd, Jacobs Engineering Group, Inc., Albuquerque, NM

**Pile Stabilization and Groundwater Protection at Title I and Title II UMTRA Project Sites**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 431-450) (April 1990)

Inactive sites in the Uranium Mill Tailings Remedial Action Project are referred to as Title I sites. Active, or Title II sites, are the responsibility of private industry. Successful remediation of both types of site and advanced plans for groundwater restoration and final pile stabilization have highlighted the differences in approaches to and details of Title I and Title II remedial actions. This paper explains those differences. The author first describes the laws and regulations that govern the programs. Then the standards formulated by the U.S. Environmental Protection Agency to govern remedial works are described. Next, technical approaches adopted for Title I and Title II sites to compile remedial designs, closure plans, and groundwater protection strategies are discussed. Case histories of both Title I and Title II sites are described. Finally, the author enumerates and discusses the reasons for the differences in the two programs highlighted by the preceding discussion.

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L.M. Coons and D.R. VanBuskirk, Sergent, Hauskins and Beckwith Geotechnical Engineers, Albuquerque, NM; Canadian Nuclear Society, Toronto, Ontario, Canada

**Solute Transport Modeling for the Preliminary Design of Shallow Aquifer Restoration Scenarios at the Grand Junction, Colorado UMTRA Project Site**

INIS-mf-12807; CONF-880943; Uranium and Electricity: The Complete Nuclear Fuel Cycle, K.H. Talbot and V.I. Lakshmanan (eds.), Proceedings of an International Symposium, Saskatoon, Canada, September 18-21, 1988, 411 pp.; (pp. 5.31-5.40) (1988)

A widely accepted two-dimensional solute transport groundwater model was used to predict the effect of selected aquifer restoration methods on the concentration and distribution of dissolved uranium ions in a shallow alluvial aquifer in Grand Junction, Colorado. Transient flow was modeled for relatively complex simulations, including: (1) the use of a bentonite slurry wall around the perimeter of the contaminated soil and aquifer, (2) a dewatering trench downgrade of the contaminant source, and (3) a major river adjacent to the contaminant source and slurry wall. Results indicated that either a well or trench system would accelerate the removal of uranium ions from the shallow aquifer. As a result, restoration of the alluvial aquifer was considered technically feasible, and preliminary designs for the selected restoration systems were made. Costs for construction and operation over a ten-year period were estimated to be between $600,000 and $3,000,000 (1987 U.S. dollars), depending upon if and/or how the contaminated water is treated after removal from the aquifer.

**450**

Environmental Monitoring and Support Laboratory, Cincinnati, OH

**Environmental Assessment of Remedial Action at the Riverton Uranium Mill Tailings Site, Riverton, Wyoming - Volume I: Text**

Book; 219 pp. (1984)

This document assesses and compares the environmental impacts of various alternatives for remedial action at the Riverton uranium mill tailings site located 2 miles southwest of Riverton, Wyoming. The site covers 173 acres and contains 70 acres of tailings and several of the original mill structures. The Uranium Mill Tailings Radiation

Control Act of 1978, Public Law 95-604, authorizes the U.S. Department of Energy to clean up the site to reduce the potential health impacts associated with the residual radioactive materials remaining at the site and at associated properties off-site. The U.S. Environmental Protection Agency promulgated standards for the remedial actions. Remedial actions must be performed in accordance with these standards and with the concurrence of the Nuclear Regulatory Commission. The preferred alternative is to stabilize the tailings at their present location by consolidating the tailings and associated contaminated soils into a recontoured pile. A radon barrier of compacted earth would be constructed over the pile, and various erosion control measures would be taken to ensure the long-term stability of the pile. An underground bentonite slurry wall would be constructed around the perimeter of the stabilized pile to minimize additional groundwater contamination. Another alternative, which would involve moving the tailings to a new location, is also assessed in this document. This alternative would generally involve greater short-term impacts and costs but would result in stabilization of the tailings at a more remote location. The no-action alternative is also assessed in this document.

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L. Flowers, B. Mukhopadhyay, and D. Gonzalez, Roy F. Weston Company, Inc., Albuquerque, NM

**Characterization and Risk Evaluation of Non-Radiological Hazardous Constituents**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 319-321) (April 1990)

Risk evaluation is used on the Uranium Mill Tailings Remedial Action (UMTRA) Project as a decision making tool to aid in determining preliminary cleanup levels and defining relative hazard levels for nonradiologic hazardous constituents. The nonradiological hazardous constituents of concern at UMTRA sites include antimony, arsenic, cadmium, chromium, copper, fluoride, lead, molybdenum, nickel, nitrate, selenium, uranium, vanadium, and zinc. The risk evaluation process is summarized.

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T.J. Goering and K. Bostick, Jacobs Engineering Group, Inc., Albuquerque, NM

**Analysis of Infiltration Through a Clay Radon Barrier at an UMTRA Disposal Cell**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 51-54) (April 1990)

Several Uranium Mill Tailings Remedial Action (UMTRA) Project disposal facilities consist of uranium mill tailings covered by a 3- to 6-ft-thick radon barrier and 6 in. of filter sand, overlain by 1 ft of erosion protection riprap. To comply with the U.S. Environmental Protection Agency (EPA) standards applicable to the UMTRA Project (10 CFR 92), site-specific groundwater concentration limits cannot be exceeded at the downgradient limit of the disposal facility (point of compliance). The typical UMTRA radon barrier is constructed of low-permeability compacted clay with a saturated hydraulic conductivity of approximately 10 to 7 centimeters per second. However, if the radon barrier is unsaturated, its operational hydraulic conductivity may be several orders of magnitude less, yielding a significantly lower steady-state seepage flux from the tailings. In this case, the disposal cell will be more likely to meet EPA groundwater concentration limits at the point of compliance. A field study was undertaken to measure the percent saturation, and the relation of present saturation, and hydraulic conductivity in the radon barrier of the Shiprock, New Mexico, UMTRA disposal cell.

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T.J. Goering, N.B. Larson, J. Crain, and L.M. Phyfe, Jacobs Engineering Group, Inc., Albuquerque, NM

## Modeling of Transient Drainage from Uranium Tailings at UMTRA Project Sites

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 292-296) (April 1990)

The Uranium Mill Tailings Remedial Action Project is charged with the task of isolating from the environment radioactive uranium mill tailings at 24 sites. This involves preventing both the surface migration of contaminants and the subsurface migration of contaminants to the groundwater. Low-permeability disposal cell covers are designed and constructed to limit the amount of water that can flow through the tailings and transport contaminants into the environment. However, when licensing a facility, a strategy of compliance with U.S. Environmental Protection Agency Groundwater Standards cannot be based solely on the anticipated flux through the cover. Often the tailings are still in a wet condition and will drain for many years to come. This "transient drainage" may be several orders of magnitude greater than the steady state flux through the cover. This poster discusses the methods used to quantify the transient drainage from the tailings.

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L.D. Hamilton, W.H. Medeiros, A. Meinhold, S.C. Morris, P.D. Moskowitz, and J. Nagy, Brookhaven National Laboratory, Upton, NY

## Health Risk Analysis for Ingestion of Contaminants from Existing Groundwater Contamination at Selected UMTRA Project Sites

BNL-44772; 84 pp. (September 1988)

This study examines potential hazards to human health from the ingestion of chemicals in groundwater beneath and adjacent to four abandoned uranium mill tailings sites: Gunnison, Colorado; Lakeview, Oregon; Monument Valley, Arizona; and Riverton, Wyoming. Chemicals of concern in the groundwater near these sites include arsenic, cadmium, chromium, lead-210, molybdenum, nitrate, polonium-210, radium-226 and radium-228, selenium, sulfate, thorium-230, uranium, and vanadium. Hazards to health were evaluated by implementing the method outlined in the Environmental Protection Agency (EPA) Superfund Public Health Evaluation Manual. Conservative assumptions in the method and the effect of these on the risk estimates and EPA's indexes of harm are discussed. Because the method has a number of built-in conservatisms, the estimated risks and indexes only indicate sites and chemicals requiring further analysis. The chemicals and sites identified as presenting risk in this first screening step should be investigated in more detail. Necessary steps are given. Sites and chemicals identified as harmless in this initial screening can be eliminated from further consideration.

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L.D. Hamilton, W.H. Medeiros, A. Meinhold, S.C. Morris, P.D. Moskowitz, J. Nagy, and K. Lackey, Brookhaven National Laboratory, Upton, NY

## Evaluation of Health Risks Associated with Proposed Ground Water Standards at Selected Inactive Uranium Mill Tailings Sites

BNL-44771; 103 pp. (April 1989)

The U.S. Environmental Protection Agency (EPA) has proposed groundwater standards applicable to all inactive uranium mill tailings sites. The proposed standards include maximum concentration limits (MCL) for currently regulated drinking water contaminants, as well as the addition of standards for molybdenum, uranium, nitrate, and radium-226 plus radium-228. The proposed standards define the point of compliance to be everywhere downgradient of the tailings pile and require groundwater remediation to drinking water standards if MCLs are exceeded. This document presents a preliminary description of the Phase 2 efforts. The potential risks and hazards at Gunnison, Colorado and Lakeview, Oregon were estimated to demonstrate the need for a risk assessment and the usefulness of a cost-benefit approach in setting supplemental standards and determining the need for and level of restoration at Uranium Mill Tailings Remedial Action sites.

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J. Isham, MK-Ferguson Company, Albuquerque, NM

**Remediation of Hazardous Wastes on UMTRA Sites**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 109-124) (April 1990)

The Uranium Mill Tailings Remedial Action (UMTRA) Project is remediating 24 inactive mill sites in 10 states. Remediation of seven sites is completed, and work is in progress at another eight sites. This presentation focuses on the remediation of hazardous materials, including mixed wastes and asbestos, at UMTRA sites. Examples of UMTRA wastes are (1) radioactive friable asbestos with toxic metals; (2) pure-grade vanadium pentoxide; (3) radioactive sulfuric acid; (4) yellow-cake uranium; and (5) drums of corrosives, flammables, and toxics. A brief overview of the UMTRA waste management process is given, along with a copy of an audit form for treatment, storage, and disposal facilities. The audit form helps to characterize waste at a site, identify potential future Superfund sites and avoid or limit legal and financial liabilities associated with negligence.

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Jacobs Engineering Group, Inc., Albuquerque, NM

**UMTRA Geomembrane Special Study**

DOE/UMTRA-400642; 39 pp. (July 1988)

The objective of the Geomembrane Special Study was to asses the suitability of geomembranes in Uranium Mill Tailings Remedial Action (UMTRA) Project pile designs. Geomembranes, also called flexible membrane liners, are made of polymer resins and are thermoplastic materials. Part of the special study was to evaluate regulatory compliance and acceptability issues. This study was proposed because of the extensive use of geomembranes in hazardous waste site remedial actions and their accepted use in Resource Conservation and Recovery Act cells as both covers and liners to limit infiltration or as part of leachate collection systems. This study has reviewed the recent geomembrane literature focusing on (1) longevity, (2) performance, (3) constructibility, and (4) quality control/quality assurance considerations. In addition to these technical considerations, regulatory compliance and acceptability concerns were also evaluated. This report describes the results of the literature review, including correspondence with manufacturers, resin producers, experts in the field, and long-term major users.

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K.O. Johnson, MK-Ferguson Company, Denver, CO

**Groundwater Impacts on UMTRA Project Designs**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 403-430) (April 1990)

Since the application of U.S. Environmental Protection groundwater regulations to the uranium mill tailings disposal regulations, groundwater issues have become the critical element of the Uranium Mill Tailings Remedial Action Project remedial designs. Designs may include elements for prevention of future groundwater impacts and restoration of existing groundwater degradation. Groundwater quality compliance standards are often based on background concentrations. Determination of the range of background concentrations requires a methodology that incorporates understanding of the mineralogy and composition of the background rock units and statistical techniques to interpret the data. Transport of contaminants from the tailings through the aquifer is a function of the hydrology and geochemistry that control the mobility of the contaminants. Designs for groundwater compliance may contain elements of both hydrology and geochemistry. Hydrologic controls such as low permeability liners and covers can be engineered and considered in selection of a site for the tailings cell. Geochemical controls can be effective in reducing the mobility of contaminants. The tailings cell may be placed on natural materials with properties effective for geochemical retardation or geochemical barriers and treatment can be part of the design.

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W.C. Knight, V. Fry, and R. Sena, Jacobs Engineering Group, Inc., Albuquerque, NM; U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

**Conceptual Design of Remedial Actions at Three Navajo Sites**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 740-746) (1986)

As part of the Uranium Mill Tailings Remedial Action Project, Jacobs Engineering, under the direction of the U.S. Department of Energy, prepared conceptual designs for three former uranium processing sites on the Navajo reservation. The objective of the design is to meet the U.S. Environmental Protection Agency standards for long-term performance by consolidating the tailings and associated contaminated materials with a system of controls that would last for 1000 years where reasonably achievable, and for at least for 200 years elsewhere. This report presents the problems and solutions associated with the designs at each site.

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S.C. Lapham and J.B. Millard, Health and Environment Department, Environmental Improvement Division, Santa Fe, NM

**Health Implications of Radionuclide Levels in Cattle Raised near Uranium Mining and Milling Facilities in Ambrosia Lake, New Mexico**

Health Physics 56(3):327-340 (1989)

Ambrosia Lake, New Mexico, has been the site of extensive uranium mining for 30 years and contains several underground uranium mines, a processing mill, and two large uranium tailings piles. Ten cows were purchased from two grazing areas in Ambrosia Lake and ten control animals were purchased from Crownpoint, New Mexico. Muscle, liver, kidney, and bone tissue taken from these animals and environmental samples, including water, grasses, and soil collected from the grazing areas, were analyzed for U-238, U-234, Th-230, Ra-226, Pb-210, and Po-210. Mean radionuclide levels in cattle tissue and environmental samples from Ambrosia Lake were higher in almost every comparison than those found in respective controls. Liver and kidney tissues were particularly high in Ra-226 and Po-210. Radiation dosage from eating cattle tissue with these radionuclide concentrations was calculated. It is concluded that the health risk to the public from eating meat from the exposed cattle is minimal, unless large amounts of this tissue, especially liver and kidney, are ingested.

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D.J. Lechel, Roy F. Weston Company, Inc., Albuquerque, NM

**Environmental Benefits from Regulatory Compliance at the Durango, Colorado UMTRA (Uranium Mill Tailings Remedial Action) Project Site**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 439-443) (1986)

Radioactivity-contaminated uranium mill wastes in Durango, Colorado, are slated for cleanup and stabilization in the near future. As part of this cleanup action, at least 18 permits/approvals must be obtained. Compliance with these permits/approvals has provided unanticipated benefits. For this remedial action, compliance will enhance wildlife habitat and improve its availability to the public at large and enhance riparian habitat. Also, it has already yielded exciting new archaeological finds.

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J.M. Longley, J. Herrington, and C. Daily, Roy F. Weston Company, Inc., Albuquerque, NM

### Graphical Quality Assurance and Data Management on the UMTRA Project

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 176-194) (April 1990)

On the Uranium Mill Tailings Remedial Action (UMTRA) Project, the Remedial Action Contractor (RAC) monitors for environmental Rn-222 and for airborne radioactive particles. This monitoring ensures the health protection of the general public and demonstrates compliance with U.S. Department of Energy (DOE) Order 5400.5; at remedial action sites, it helps in evaluating the need for worker protection and ensures that workers are not exposed to radioactive materials above the concentration limits specified in DOE Order 5480.11. Because of the geographic separation of the sites and the fact that multiple actions are performed concurrently, environmental data management is of critical importance. Therefore the RAC has developed a comprehensive computer data base management system for management of environmental monitoring, personnel monitoring, and soil verification data. One of the cornerstones of this data base system is graphical presentation of data. The RAC summarizes four types of data in a graphical format, including (1) environmental radon monitoring data, (2) environmental particulate monitoring data, (3) occupational air particulate monitoring data, and (4) daily quality control checks for NaI(Tl) spectrometers. This paper details the use, data management system, methodology, quality assurance, and future of this graphical data presentation. The graphical data presentation as detailed here allows environmental monitoring, occupational monitoring, and detector quality control checking to be rapidly summarized in an understandable format. Thus, the management of the UMTRA Program is better informed on how the remedial activities are impacting the environment and the health of project workers. The graphical data presentation also allows rapid summary of data in a number of formats, especially the format required to demonstrate compliance with DOE Order 5400.5.

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### Application of Geochemical Barriers for Immobilizing Hazardous Constituents in Uranium Mill Tailings

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 68-108 (April 1990)

This investigation examined three potential geochemical modifiers to determine their ability to immobilize inorganic groundwater contaminants found in uranium mill tailings. The three modifiers were (1) hydrated lime, (2) limestone, and (3) a sphagnum-moss peat. The investigation had two principal objectives. The first was to determine the effects of geochemical modifiers on the solubility, and therefore the mobility, of major inorganic contaminants associated with uranium mill tailings (including arsenic, molybdenum, nitrate, selenium, and uranium). The second objective was to determine the effects of geochemical modifiers on the geotechnical characteristics of uranium mill tailings. Parameters of interest included hydraulic conductivity, volume changes resulting from geochemical reactions, and changes in shear and compressive strengths of modified tailings. The investigation determined that addition of the geochemical modifiers to uranium mill tailings results in a decrease (to below U.S. Environmental Protection Agency maximum concentration limits) in the concentrations of arsenic, cadmium, chromium, lead, molybdenum, selenium, and uranium. Removals over 90% appear feasible at peat-hydrated lime concentrations of approximately one weight-percent each. The investigation found that the most efficient use of the geochemical modifiers would be (a) to mix them into the

tailings piles, (b) to place them as a base layer within the embankment, and (c) to excavate a trench downgradient of the embankment and fill the trench with barrier materials. Additional applications of the investigation results are to groundwater restoration and to handling transient drainage associated with construction. The economic evaluation of using geochemical modifiers would take into consideration the expense of pumping and treating contaminated groundwater over a relatively long period of time versus the more capital-intensive, short-term installation of a geochemical barrier.

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**A Perspective on Department of Energy-State Cooperation on Remedial Action Projects**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 583-584) (1988)

This paper discusses how the DOE Office of Remedial Action and Waste Technology cooperates with states in implementing its projects. The author reviews some of these projects and the issues that have arisen.

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M.L. Matthews, U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**Quality Assurance Overview**

CONF-890487; Proceedings of an International Waste Management Conference, Las Vegas, NV, April 2-5, 1989 (1989)

This paper discusses the development and implementation of the quality assurance program at 24 Uranium Mill Tailings Remedial Action Project sites. The author describes the quality assurance procedures involved in the site investigations and characterization activities, as well as the quality control and quality assurance associated with the engineering, design construction, and inspection services necessary to accomplish cleanup and permanent stabilization at the sites.

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**A Detailed Hydrogeologic Field Investigation of the UMTRA Project at the Cheney Disposal Site, Grand Junction, Colorado**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 173-174) (April 1990)

Compliance with the U.S. Environmental Protection Agency (EPA) groundwater standards (40 CFR 192, Subparts A,C) requires a hydrogeologic characterization of the proposed disposal site. This characterization is the basis for developing a water resource protection strategy that will demonstrate that EPA groundwater standards will be met at the point of compliance. The Cheney tailings disposal site is in the Colorado plateau, in west central Colorado, between the Uncompahgre uplift and Piceance basin. Hydrogeologic characterization included coring to determine lithology and multiple pilot geophysical methods, followed by an extensive EM-34 geophysical survey to distinguish bedrock contacts. Test pits and continuous trenching were used to differentiate saturated soils from unsaturated soils. These methods identified a hydrostratigraphy that includes, in descending order (1) alluvium, (2) weathered Mancos Shale, (3) unweathered Mancos Shale, and (4) Dakota Sandstone. Within the site vicinity, shallow groundwater occurs in the alluvium in paleochannels incised into the Manco Shale. Continuous trenching, test pitting, and well monitoring were used to define areas of saturation

within the alluvium. Flow rate measurements into the trenches and pumping tests in the alluvium indicate the groundwater is not of limited use (Class 3). To avoid having to address the groundwater in the paleochannels as the upper-most aquifer, the field investigation defined an area of "Mancos high" disassociated from saturated paleochannels. The Dakota Sandstone, overlain by 700 ft of Mancos Shale, was then identified as the uppermost aquifer. Double ring infiltrometer tests, rising-head and falling-head borehole permeameter tests, constant head infiltration tests, and packer tests were conducted to measure the hydraulic conductivity of the Mancos Shale. Potentiometric levels suggest an upward gradient between the Dakota Sandstone and the Mancos Shale. Compliance with EPA groundwater standards will be demonstrated by the fact that the travel time of seepage from the base of the disposal cell to the uppermost aquifer is greater than 1000 years.

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**Environmental Monitoring: The Uranium Mill Tailings Remedial Action Project**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 33-39) (1990)

The Uranium Mill Tailings Remedial Action Project is the country's most successful remediation program. Five of 24 large uranium mill tailings sites are finished and 7 are underway. From the beginning, Chem-Nuclear Systems, Inc. has been responsible for all radiation protection, cleanup standards verification, and environmental monitoring on the project. The Chem-Nuclear data base, developed over the last 6 years, is standardized and quality-controlled. Multiple-location and background measurements at each site have quantified radon, Ra-226, and Th-230 concentrations, along with gamma dose rate. Summaries of preconstruction environmental data and data recorded during and after remedial action are presented. The type and effectiveness of remedial actions performed on each tailings pile are discussed.

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**Implementation of a Procedure to Determine Remedial Action Requirements for Contamination at Uranium Mill Tailings Sites**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 577-584) (1989)

This paper describes a procedure used at the Riverton and Green River Uranium Mill Tailings Remedial Action (UMTRA) Project sites to determine the removal of chemical contaminants from subpile soils necessary to achieving safe levels. Cleanup criteria for chemical contaminants were developed independently of existing cleanup criteria for radionuclides. The two sites were chosen because they were representative of all twenty-four UMTRA sites and were scheduled to undergo remediation in the near future. An initial compilation of existing data indicated that additional analyses were required to fully characterize the site for arsenic, molybdenum, selenium, uranium, and vanadium. Accordingly, archived samples from prior radiological characterizations for the tailings pile, subpile, mill yard, and windblown areas were selected for subsequent laboratory analyses.

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B. Mukhopadhyay and J. Fritts, Roy F. Weston Company, Inc., Albuquerque, NM

### Hazardous Organic Constituents in the UMTRA Title I Series

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 169-172) (April 1990)

The U.S. Department of Energy is conducting a complete characterization of the tailings and associated groundwaters at the Uranium Mill Tailings Remedial Action (UMTRA) sites. This characterization is being conducted to establish which of the hazardous constituents listed in the Environmental Protection Agency (EPA) Draft Final 40 CFR 192 (groundwater standards for UMTRA sites) exceed the regulated concentrations at these sites and pose potential risks to human health and the environment. This paper deals with the results of a screening for the hazardous organic constituents (HOC) at the above UMTRA sites which were used to determine whether detailed HOC investigations are needed at any of these sites. The HOC were screened using analytical methods suggested by EPA (40 CFR 264) in accordance with the EPA quality assurance program and the results given here. It is necessary to evaluate whether the elevated concentration levels of the HOC observed in the groundwaters of the New Rifle, Falls City, and Naturita sites pose risks to human health and the environment. The results of this evaluation will determine whether detailed HOC investigations are warranted at any of these sites.

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### Small-Scale Field Test of Simple Earthen Covers for Uranium Mill Tailings

DOE/UMTRA-19; 36 pp. (January 1983)

A series of field tests has been conducted during the past year to provide benchmark data on the performance of simple, single-layer earthen covers at three uranium tailings sites. The performance of the covers was evaluated in terms of their reduction of radon gas releases, although moisture profiles and other cover parameters were also monitored. The tests were designed to evaluate the effectiveness of local soils applied with minimum engineering design or compaction effort. The tests therefore tend to represent a lowest-cost, and perhaps a worst-case scenario for tailings reclamation. The field benchmark tests are part of a major research program being conducted by the U.S. Department of Energy to develop technology for uranium tailings disposal. The present tests with simple earthen covers thus provide a comparative basis for evaluating the effectiveness of more highly-engineered systems and their proportionately higher costs. These tests were conducted on the inactive tailings piles at Salt Lake City and Mexican Hat, Utah and Grand Junction, Colorado. The test covers were installed during the summer of 1981 and were monitored during the following year. This report describes the experimental details of the cover tests, the data that were collected during the one-year monitoring period, and the conclusions that were drawn from the experiments.

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J.B. Pricel, J.E. Brinkmanl, and D. Gonzalez, Roy F. Weston Company, Inc., Albuquerque, NM

### The Uranium Mill Tailings Remedial Action Project: A Retrospection

CONF-8711156; Water Resources Related to Mining and Energy: Preparing for the Future, R.F. Dworsky (ed.), Proceedings of the 23rd American Water Resources Association Annual Conference, Salt Lake City, UT, November 1-6, 1987. American Water Resources Association, Bethesda, MD, 561 pp.; (pp. 539-550) (1987)

The Uranium Mill Tailings Remedial Action (UMTRA) Project is a U.S. Department of Energy program which is stabilizing inactive uranium mill tailings. The protection of water resources is a key part of stabilization. The program serves as an important precedent for other programs to control wastes including, implicitly, mixed waste. A Technology Development Program within the UMTRA Project developed site characterization data and a conceptual model for the movement of contaminants in mill tailings and their environs. The protection of water resources is constrained by other design criteria for tailings stabilization. Ongoing characterization and modeling of UMTRA Project sites represent a large data base and multiple-site case study which should be used as sources of information to develop portions of the technical approaches and generic conceptual models to be used in other waste programs. This data base includes techniques for laboratory quality assurance and infiltration modeling.

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**Geotechnical and Construction Considerations of the Salt Lake City UMTRA (Uranium Mill Tailings Remedial Action) Project**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 747-751) (1986)

The conceptual design called for relocating the tailings, mill rubble, and other contaminated soils from the Vitro site in the urban Salt Lake City, Utah, area 136 kilometers west to the remote South Clive Site. This paper (1) briefly describes the layout of the remedial action at both sites, (2) details problems encountered in implementing the remedial action, and (3) presents solutions that will be used to facilitate completion of the project within the second construction season. Construction has provided valuable experience on handling mill tailings during remedial action.

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**Vegetative Covers for UMTRA Project Disposal Cells**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 421-426); CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 307-318) (1990)

The goal of the Uranium Mill Tailings Remedial Action (UMTRA) Project is to clean up and permanently stabilize uranium mill tailings and other contaminated materials at 24 inactive mill sites in the United States. The basic approach is to consolidate the contaminated materials into gently sloped piles and then to cover the contaminated materials with earthen layers that will control radon emanation, resist erosion, and prevent the infiltration of excess moisture that might dissolve and transport hazardous constituents. The most widely-used cover design, called a rock cover, consists of a compacted clay radon barrier overlain by a filter layer overlain by erosion-resistant rock. This cover design continues to be used for sideslopes at most sites and for both topslopes and sideslopes in highly arid environments. Vegetative covers are now proposed for use on topslopes of disposal cells at UMTRA Project sites in less arid environments. Vegetative covers generally consist of the components described above, but with an overlying layer of carefully selected soil, upon which a locally adapted plant community is established. The three principal advantages of vegetative covers are (1) control of water balance; (2) enhanced protection against root penetration of the radon barrier relative to rock covers; and (3) consistency of the "climax vegetation" concept with the 1000-yr (200-yr minimum) design life for disposal cells on the UMTRA Project. The major liabilities of vegetative covers are their reduced resistance to erosion, relative to rock covers, and

their vulnerability to disturbances such as fire, drought, or heavy grazing. However, a properly established vegetative cover will be self-healing, reestablishing protective biomass and restoring water balance after periods of disturbance and reduced performance. This paper details the developments that have led to the increased use of vegetative covers on the UMTRA Project and identifies the factors that are considered in selecting a cover system. Progress in this arena represents an integration and application of research findings from experimental programs throughout the waste management community; these experiences may be of value to other programs requiring a choice of cover systems among several alternatives.

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**DECHEM: A Program for Characterizing and Mitigating Chemical Contamination at UMTRA Projects**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 585-591) (March 1989)

The Decontamination of Chemicals (DECHEM) method was developed on the Uranium Mill Tailings Remedial Action (UMTRA) Project to guide characterization for remedial planning for heavy-metal contamination in soils. This is necessary because metals and metalloids such as arsenic, lead, molybdenum, selenium, uranium, and vanadium that are sometimes associated with the mill tailings may be more mobile than radium-226, hence may migrate more deeply into subpile soils beneath tailings that are to be relocated or into adjacent contaminated materials at UMTRA Project sites. The result is that remedial action to the radium-226 excavation limit, as specified in UMTRA legislation, may not remove all hazardous nonradiological contamination. The DECHEM method was developed in response to the need for advanced planning for the remediation of chemical contaminants at UMTRA sites and includes the following elements: (1) maximum use of existing data and samples, (2) establishment of acceptable exposure rates to chemicals, (3) pathway modeling of chemical migration, and (4) determination of acceptable residual concentrations. At the heart of the method is the DECHEM code, which consists of pathway models to quantify contaminant migration from source term to humans. Inputs to the code include site-specific environmental data, concentrations of chemical contaminants, and maximum allowable uptake rates (by humans) for each chemical. The code iteratively evaluates possible cleanup scenarios until it determines what depth of excavation will ensure that the combined exposure to humans (of all heavy metals by all exposure models) is acceptably low. An acceptable exposure is one in which the sum of all reference values (actual exposure divided by maximum allowable exposure) is less than one. The DECHEM method was implemented on a trial basis at the UMTRA sites in Riverton, Wyoming, and Green River, Utah, to refine the site characterization process, to determine if the cleanup guidelines specified by DECHEM are realistic, and to provide a starting point for sensitivity analysis. A regulatory analysis was also performed to evaluate the consistency of the DECHEM method with existing and anticipated regulations, including groundwater standards that will soon be promulgated by the Environmental Protection Agency for the UMTRA Project. This paper describes the development of the DECHEM method and its applicability to the requirements of the UMTRA Project. Another paper given at Waste Management '89 describes the initial implementation of the Riverton and Green River sites.

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**Lung Cancer Risks in the Vicinity of Uranium Tailings Sites**

DOE/UMTRA-183; 48 pp. (April 1982)

Lung cancer mortality data of interest to the Uranium Mill Tailings Remedial Action (UMTRA) Project have been assembled for many countries. The counties generally either contain UMTRA tailings sites or are adjacent to them. The lung cancer rates of nearly all the counties are less than the United States average rate. Some of the many factors associated with lung cancer are identified, as are cancer risk estimators for radon daughters.

**476**

R.D. Sanders, K.E. Karp, and J.E. Bennett, UNC Geotech, Inc., Grand Junction, CO

**UMTRA Grand Junction Vicinity Properties Commingled Waste Project in Investigation: A Case History**

CONF-900210 (Vol. 2); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - HLW and LLW Technology, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2, 988 pp.; (pp. 503-508) (1990)

During the course of performing work under the Uranium Mill Tailings Remedial Action program, UNC Geotech discovered that, because of past business-related operations, certain properties included in the Grand Junction Vicinity Property Project had the potential for containing commingled waste. As a result, UNC Geotech initiated a new project, the Commingled Waste Investigation Project, to further characterize those properties determined to have a possibility of containing commingled waste.

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Sandia National Laboratories, Albuquerque, NM; Roy F. Weston Company, Inc., Albuquerque, NM

**Engineering Feasibility Analysis for In-Situ Stabilization of Canonsburg Residues**

DOE/UMTRA-170; 125 pp. (January 1982)

The U.S. Department of Energy (DOE) is considering several methods for carrying out remedial actions in Canonsburg, Pennsylvania, at the site of an inactive uranium-processing mill. The main objective of this study is to determine the feasibility of in situ stabilization as the remedial action. In situ stabilization is an alternative to site decontamination and off-site disposal. The problems associated with off-site hauling of large quantities of contaminated material and with the location and development of a new disposal site could be avoided by the implementation of an in situ stabilization concept. In addition, the in situ approach would be more cost-effective than off-site disposal. This study will establish that a technically feasible and implementable in situ stabilization concept can be developed that meets regulatory requirements and is cost effective. This study in no way commits DOE to implement any specific actions described herein.

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Sandia National Laboratories, Albuquerque, NM; Roy F. Weston Company, Inc., Albuquerque, NM

**Engineering Feasibility Analysis for In-Situ Stabilization of Burrell Township Site Residues**

DOE/UMTRA-187; 137 pp. (November 1982)

The Burrell Township site, located in western Pennsylvania, received approximately 11,600 tons of radioactively-contaminated material in late 1956 and early 1957 from Vitro Manufacturing Company operations in Canonsburg, Pennsylvania. Weston was asked to conduct an engineering study to determine the feasibility of stabilizing the site in accordance with the U.S. Environmental Protection Agency (EPA) interim and proposed standards (Federal Register 45:27366-27368, April 22, 1980, and Federal Register 46:2556-2563, January 9, 1981). The scope of this study is limited to alternatives that can be implemented on the site and that will not require removal and off-site disposal of radioactively contaminated material. Four alternatives for control of the radioactive material at the Burrell site were considered and evaluated: (1) site stabilization and closure, (2) site control and containment, (3) waste excavation and encapsulation, and (4) waste excavation, incineration, and encapsulation.

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**Geologic Considerations in Siting and Design of Long-Term Disposal Sites for Uranium Mill Tailings**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 593-602) (March 1989)

Under the Uranium Mill Tailings Remedial Action Project, the U.S. Department of Energy is responsible for the long-term isolation of radioactive mill tailings and other associated waste materials at 24 sites, located primarily in the western U.S. Most of these sites are former uranium mills that were active from the 1950s to the 1970s and have since been abandoned. Potential hazards to public health at and near these facilities are generated by the presence of varying concentrations of radionuclides, heavy metals, acids, and other contaminants. The purpose of geologic site characterization is to evaluate the long-term stability of the disposal facilities as it applies to the risk of failure from geologic processes. At most sites, geomorphic processes represent the most significant hazards. Other important concerns can include possible groundwater and surface water quality impacts, seismic risk and resource development potential of the site. Project geologists interact with geotechnical engineers, hydrologists, and others to solve complex problems of which geologic hazards represent only one element. Engineering design considerations, availability of borrow materials, construction and transportation costs, and complex groundwater issues must all be considered in the final design at each site. The engineering geologist must understand and be able to work within this broader framework to make an effective contribution.

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**Demonstration of an Infiltration Evaluation Methodology**

PNL-SA-17602;CONF-900794;Environmental Engineering, Proceedings of an ASCE Conference, Washington, DC, July 9-11, 1990; (9 pp.) (July 1990)

An Infiltration Evaluation Methodology (IEM) was developed for the U.S. Nuclear Regulatory Commission (NRC) by Pacific Northwest Laboratory to provide a consistent, well formulated approach for evaluating drainage through engineered covers at low-level radioactive waste (LLW) sites. The methodology is designed to help evaluate the ability of proposed waste site covers to minimize drainage for LLW site license applications and for sites associated with the Uranium Mill Tailings Remedial Action Program. The objective of this methodology is to estimate the drainage through an engineered burial site cover system. The drainage estimate can be used as an input to a broader performance assessment methodology currently under development by the NRC. The methodology is designed to simulate, at the field scale, significant factors and hydrologic conditions that determine or influence estimates of infiltration, long-term moisture content profiles, and drainage from engineered covers and barriers. The IEM developed under this study acknowledges the uncertainty inherent in soil properties and quantifies the influence of such uncertainty on the estimates of drainage in engineered cover systems at waste disposal sites.

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**Construction Water Impacts on UMTRA Designs**

CONF-900418* (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 29-50) (April 1990)

To introduce the subject of construction water at Uranium Mill Tailings Remedial Action Project sites and to provide background information regarding this subject, this report begins with the description of recent experience at the Durango, Colorado, site. The paper goes on to present (1) what was done at this site, (2) what can be done for future sites so that construction water seepage will not happen, and (3) what construction and design problems may accompany the solutions.

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J.A. Turi, U.S. Department of Energy, Division of Uranium Mill Tailings Projects, Washington, DC

**Overview of the Uranium Mill Tailings Remedial Action Project**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 41-44) (1986)

The U.S. Department of Energy is conducting a uranium mill tailings management program to protect human populations and the environment, both now and in the future, from potential harmful exposure to contaminants contained in the tailings. The program is focused on isolating and stabilizing 24 inactive mill tailings piles at 22 locations with an estimated volume of 24,000,000 tons. This paper discusses remedial actions in progress and outlines future plans.

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U.S. Congress, House of Representatives, Committee on Interior and Insular Affairs, Washington, DC

**Uranium Revitalization, Tailings Reclamation, and Enrichment Legislation - Hearing Before the Subcommittee on Energy and the Environment of the U.S. Congress, House Committee on Interior and Insular Affairs, on H.R. 4489 and H.R. 4591**

U.S. House of Representatives, Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment, One Hundredth Congress, Second Session, June 28, 1988, Serial No. 100-78, U.S. Government Printing Office, Washington DC, 1989; 4 pp. (1988)

This document lists the Committee and Subcommittee members and the agenda of the subject hearing on proposed legislation House Resolution 4489: to provide for a viable domestic uranium industry, to establish a program to fund reclamation and other remedial actions with respect to mill tailings at active uranium and thorium sites, and to establish a wholly-owned government corporation to manage the nation's uranium enrichment enterprise; and House Resolution 4591 to amend the Uranium Mill Tailings Radiation Control Act of 1978.

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

**Ceremony to Commemorate Tailings Cleanup at Tuba City**

DOE News (900423):1 (April 23, 1990)

This newsletter announces a ceremony given by DOE, the Navajo Nation, and the Hopi Tribe to commemorate completion of the remedial action on the tailings pile at the inactive rare metals/uranium processing site 6 miles east of Tuba City, Arizona. The cleanup of tailings at the Tuba City site was conducted in two phases. Phase I included demolition of the main mill building and other site preparation activities, completed in 1986. The Phase II cleanup, which consisted of stabilizing the contaminated materials on the site, began in 1988. The tailings and contaminated materials were consolidated into a single pile. The pile was covered with a compacted soil layer to reduce water infiltration and control radon emanation, and with a rock layer to protect against erosion. Disturbed areas around the pile were backfilled with uncontaminated soil, recontoured, and revegetated. Phase II was completed in 1990. DOE will be evaluating contamination found in the groundwater beneath the Tuba City tailings site as a follow-up action. Groundwater protection standards have been proposed for the Uranium Mill Tailings Remedial Action Project by the U.S. Environmental Protection Agency; final standards to be released later will address groundwater contamination at the site. The Tuba City site is one of four sites on Indian lands that has been or is being addressed under the Uranium Mill Tailings Radiation Control Act of 1978.

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

**Uranium Mill Tailings Remedial Action Project/Underground Water Restoration (UMTRA/UGR) 1990 Site Specific Plans Available**

DOE News (900904):1-2 (September 4, 1990)

As part of its Environmental Restoration and Waste Management Five-Year Plan, the U.S. Department of Energy announces a 60-day period of public comment following the release of a site-specific plan for the 24 inactive uranium mill processing sites associated with the Uranium Mill Tailings Remedial Action Project/Underground Water Restoration (UMTRA/UGR) Project.

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U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM

**Ceremony Marks Completion of Durango Tailings Cleanup**

DOE News (901101):1-2 (November 1, 1990)

The U.S. Department of Energy and the state of Colorado formally marked completion of the Uranium Mill Tailings Remedial Action Project today at Durango, Colorado.

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**DOE to Hold Public Meetings on Monument Valley/Mexican Hat Tailings Cleanup**

DOE News (901119):1-2 (November 19, 1990)

This newsletter announces a public information meeting to be held by the U.S. Department of Energy (DOE) and the Navajo Nation on November 27, 1990, to provide an update on the Monument Valley/Mexican Hat Uranium Mill Tailings Remedial Action Project. Updated plans, schedules, and a progress report will be presented. The Navajo Nation has entered into a cooperative agreement with DOE to remediate the Monument Valley and Mexican Hat sites. Remedial action at the sites involves stabilizing tailings to meet standards for protection of public health and the environment set by the U.S. Environmental Protection Agency.

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**Mill Tailings Cleaned Up on 23 Lowman Properties**

DOE News (901126):1-2 (November 26, 1990)

This newsletter announces the completion by DOE and the Idaho Department of Health and Welfare of the cleanup of 23 properties in the vicinity of the inactive Lowman uranium mill tailings site. The properties are near the locations where tailings were used in construction or transported by wind or water erosion. The former Porter Brothers uranium mill at Lowman has been abandoned since 1960. The site covers 35 acres and contains approximately 88,750 cu yd of radioactive sands scattered over the site. Contractors for DOE and the Idaho Department of Health and Welfare hauled a 13,411 cu yd of contaminated material from nearby properties to the mill site. Sixteen properties were originally scheduled for cleanup in 1990 at a construction cost estimated at $1.27 M; contractors cleaned up 23 sites within the same schedule and budget.

Eleven additional nearby properties with approximately 15,000 cu yd of contaminated material are scheduled to be cleaned up in the spring and summer of 1991.

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**Public Meeting to be Held on Falls City, Texas, Tailings Cleanup**

DOE News (910118):1-2 (January 18, 1991)

This newsletter announces a public meeting February 7, 1991, held by DOE and the Texas Department of Health, regarding plans to cleanup the inactive Susquehanna-Western uranium processing site. The site, inactive since 1982, includes two parcels of 185.8 and 54.3 hectares (459 and 134 acres). An estimated 4,434,000 cu m (5,764,000 cu yd) of contaminated material will be cleaned up on the site and adjacent properties. The proposed remedial action involves combining the contaminated material into a single embankment and stabilizing the tailings and other contaminated materials in accordance with U.S. Environmental Protection Agency standards for longevity, control of radon emanation, and groundwater protection. The Susquehanna-Western site is one of 24 inactive uranium mill tailings sites nationwide being cleaned up by DOE as part of the Uranium Mill Tailings Action (UMTRA) Project. To date, remedial action has been completed at eight UMTRA sites: (1) Canonsburg, Pennsylvania; (2) Shiprock, New Mexico; (3) Salt Lake City, Utah; (4) Green River, Utah; (5) Lakeview, Oregon; (6) Tuba City, Arizona; (7) Riverton, Wyoming; and (8) Spook, Wyoming.

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**DOE Record of Decision at Rifle Sites**

DOE News (910125):1-2 (January 25, 1991)

This newsletter announces the issuance by the U.S. Department of Energy (DOE) of a Record of Decision (ROD) concerning cleanup of uranium mill tailings from the two former Union Carbide Corporation uranium processing sites at Rifle, Colorado. Issuance of the ROD concludes compliance activities at Rifle required under the National Environmental Policy Act before cleanup may proceed. The ROD documents the DOE decision to relocate contaminated materials from the Rifle sites and associated properties to a remote site at Estes Gulch for permanent disposal. The decision was based on an evaluation of costs and environmental impacts from several alternatives. The two inactive uranium processing sites lie in the Colorado River valley near the city of Rifle. The tailings and other contaminated materials will be transported by truck to the Estes Gulch site, approximately seven miles north of the city, where they will be buried partly below ground and covered with layers of earth and rock. Activities in preparation for tailings relocation are scheduled to begin in Spring, 1991.

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**DOE Begins Train Removal of Uranium Tailings at Grand Junction**

DOE News (910311):1 (March 11, 1991)

This news release is public notice that on March 11, 1991, DOE began hauling uranium mill tailings from Grand Junction as part of the Uranium Mill Tailings Remedial Action (UMTRA) Project. With the agreement of the state of Colorado, the tailings were hauled by both train and truck to the Cheney disposal site 18 miles southeast of Grand Junction. The removal of 3.95 million cu m is scheduled to be completed in 29 months.

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**DOE Releases UMTRA Planning Documents for Public Review**

DOE News (910405):1-5 (April 5, 1991)

This news release announces the release for public review of planning documents for the Uranium Mill Tailings Remedial Action/Uranium Mill Tailings Groundwater Restoration (UMTRA/UMTGR) Project prepared using the new DOE Priority Scoring System. The Priority Scoring System classifies activities as emergency activities, time-critical activities, or other high-benefit and time-sensitive activities. The system then develops three different scenarios based on varying levels of funding for each project. Priority system rankings of the 24 UMTRA/UMTGR project sites, Activity Data Sheets, and background information are available at public information repositories (listed) near the sites.

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**DOE Begins Lowman Mill Site Cleanup**

DOE News (910410):1-3 (April 10, 1991)

This news release announces the beginning of cleanup at the abandoned uranium mill site in Lowman, Idaho. In addition to the mill site, 11 nearby properties will be cleaned up over 7 months. The Lowman site is one of 24 inactive uranium mill sites nationwide being cleaned up by DOE as part of the Uranium Mill Tailings Remedial Action Project. The nearby properties are areas away from the mill site where tailings or radioactive sands were used in construction or transported by wind or water erosion. The radioactive sands, which were left after commercial milling operations by Porter Brothers Corporation at Lowman were terminated, contain radium that releases radon gas as it undergoes radioactive decay. Approximately 68,000 cu m (88,750 cu yd) of radioactive sands and contaminated material on the site will be consolidated into a single pile, along with 29,211 cu m (38,730 cu yd) of contaminated material from the nearby properties. The entire pile of contaminated sands and material will be stabilized with a cover designed to prevent the escape of radon and to resist erosion. Once the disposal cell is completed in late October, 1991, a surveillance and monitoring program will be planned to ensure that the tailings remain isolated from the environment. The $8.9 million cost of the remedial action project is being shared between the federal government (90%) and the state of Idaho (10%).

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**Surface Cleanup of Shiprock UMTRA Site Completed**

DOE News (910703):1-2 (July 3, 1991)

The U.S. Department of Energy (DOE) has announced that the Nuclear Regulatory Commission (NRC) has concurred in the certification of the Shiprock, New Mexico site. This concurrence signifies that the surface cleanup of the low-level radioactive uranium mill tailings at Shiprock has been completed. This is a major step toward receiving an NRC general license for the site's custody and long-term care. The next step in the licensing process will be to prepare a long-term surveillance plan which will describe DOE's plan to ensure the long-term protection of human and the environment from radon emanation at the Shiprock site. Once accepted by NRC, the site will be brought under the general license.

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**Summary Report on Reprocessing Evaluation of Selected Inactive Uranium Mill Tailings Sites**

DOE/UMTRA-0020; 44 pp. (September 1983)

Sandia National Laboratories has been assisting the U.S. Department of Energy in the Uranium Mill Tailings Remedial Actions (UMTRA) Project, the purpose of which is to implement the provisions of Title I of Public Law 95-604, Uranium Mill Tailings Radiation Control Act of 1978. As part of this program, there was a need to evaluate the mineral concentration of the residual radioactive materials at some of the designated processing sites to determine whether mineral recovery would be practicable. Accordingly, Sandia contracted Mountain States Research and Development (MSRD), a division of Mountain States Mineral Enterprises, to drill, sample, and test tailings at 12 sites to evaluate the cost of and the revenue that could be derived from mineral recovery. UMTRA-related environmental and engineering sampling and support activities were performed in conjunction with the MSRD operations. This summary report presents a brief description of the various activities in the program and of the data and information obtained and summarizes the results.

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**UMTRA Technical Approach Document**

DOE/UMTRA-050425-0002; 305 pp. (December 1989)

The Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604 (PL95-604), grants the Secretary of Energy the authority and responsibility to perform such actions as are necessary to minimize radiation health hazards and other environmental hazards caused by inactive uranium mill sites. This Technical Approach Document describes the general technical approaches and design criteria adopted by the U.S. Department of Energy to implement remedial action plans (RAPS) and final designs that comply with U.S. Environmental Protection Agency (EPA) standards. It does not address the technical approaches necessary for aquifer restoration at processing sites; a guidance document, currently in preparation, will describe aquifer restoration concerns and technical protocols. This document is a second revision to the original document issued in May 1986; the revision has been made in response to changes to the groundwater standards of 40 CFR 192, Subparts A-C, proposed by EPA as draft standards. New sections were added to define the design approaches and designs necessary to comply with the groundwater standards. These new sections are in addition to changes made throughout the document to reflect current procedures, especially in cover design, water resources protection, and alternate site selection; only minor revisions were made to some of the sections. Section 3.0 is a new section defining the approach taken in the design of disposal cells; Section 4.0 has been revised to include design of vegetated covers; Section 8.0 discusses design approaches necessary for compliance with the groundwater standards; and Section 9.0 is a new section dealing with nonradiological hazardous constituents.

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**UMTRA Public Participation Plan**

DOE/UMTRA-10; 21 pp. (June 1984)

The purpose of this Public Participation Plan is to describe the U.S. Department of Energy's plan for involving the public in the decision making process required by the National Environmental Policy Act of 1969 as related to the Uranium Mill Tailings Remedial Action Project. This project was authorized by congress in the Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604. The act provides for a cooperative effort with affected states and Indian tribes for the cleanup of designated inactive uranium mill tailings sites and associated vicinity properties, which are located in ten western states and in Pennsylvania. The act was amended in 1982 to also include vicinity properties contaminated with residual radioactive material in Edgemont, South Dakota.

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**Procedures for Preparation, Printing, and Distribution of UMTRA Project National Environmental Policy Act Documents**

DOE/UMTRA-150127; 90 pp. (August 1988)

This paper discusses the procedures for preparation, printing and distribution of Uranium Mill Tailings Remedial Action Project National Environmental Policy Act documents.

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**UMTRA Project Environmental, Health, and Safety Plan**

DOE/UMTRA-150224-0006; 28 pp. (February 1989)

The basic health and safety requirements established in this plan are designed to provide guidelines to be applied at all Uranium Mill Tailings Remedial Action (UMTRA) Project sites. Specific restrictions are given where necessary. However, an attempt has been made to provide guidelines that are generic in nature and allow for evaluation of site-specific conditions. Health and safety personnel are expected to exercise professional judgment when interpreting these guidelines to ensure the health and safety of project personnel and the general population. This UMTRA project Environmental, Health, and Safety (EH&S) plan specifies the basic federal health and safety standards and special U.S. Department of Energy requirements applicable to this program. In addition, it delineates for responsibilities carrying out this plan. Some guidance on program requirements and radiation control and monitoring is also included. An EH&S plan is to be developed as part of the remedial action plan for each mill site and associated disposal site. Special conditions at the site which may present potential health hazards will be described, and special areas that should be addressed by the remedial action contractor (RAC) will be indicated. Site-specific EH&S concerns will be addressed by special contract conditions in RAC subcontracts.

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**Outdoor Radon Monitoring Plan for the UMTRA Project Sites**

DOE/UMTRA-150225; 21 pp. (February 1986)

This document describes the monitoring schedules and methods used to measure ambient radon concentrations around Uranium Mill Tailings Remedial Action (UMTRA) Project sites. Radon monitoring at both processing sites and disposal sites is performed primarily for two reasons. The first, and foremost, of these is to provide a means to keep the off-site radon concentrations during the construction activities as low as reasonably achievable (ALARA). The second purpose is to provide a basis for comparison with U.S. Environmental Protection Agency standards developed for UMTRA. Radon monitoring data are also used to demonstrate compliance with ambient concentration standards and for public information stemming from concern about potential radiation releases during construction.

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**Programmatic Environmental Report for Remedial Actions at UMTRA (Uranium Mill Tailings Remedial Action) Project Vicinity Properties**

DOE/UMTRA-150327; 55 pp. (March 1985)

This environmental report examines the environmental consequences of implementing a remedial action that would remove radioactive uranium mill tailings and associated contaminated materials from 394 vicinity properties near 14 inactive uranium processing sites included in the Uranium Mill Tailings Remedial Action (UMTRA) project pursuant to Public Law 95-604, the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. Vicinity properties are those properties in the vicinity of the UMTRA project inactive mill sites, either public or private, that are believed to be contaminated by residual radioactive material originating from one of the 14 inactive uranium processing sites, and which have been designated under Section 102(a)(1) of UMTRCA. The principal hazard associated with the contaminated properties results from the production of radon, a radioactive decay product of the radium contained in the tailings. Radon, a radioactive gas, can diffuse through the contaminated material and be released into the atmosphere, where it and its radioactive decay products may be inhaled by humans. A second radiation exposure pathway results from the emission of gamma radiation from uranium decay products contained in the tailings. Gamma radiation emitted from contaminated material delivers an external exposure to the whole body. If the concentration of radon and its decay products is high enough and the exposure time long enough, or if the exposure to direct gamma radiation is long enough, cancers may develop in persons living and working at the vicinity properties.

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**Project Licensing Plan for UMTRA (Uranium Mill Tailings Remedial Action) Sites**

DOE/UMTRA-150524; 30 pp. (July 1984)

The purpose of the Uranium Mill Tailings Remedial Action (UMTRA) Project Licensing Plan is to establish how a disposal site will be licensed and to provide responsibilities of participatory agencies as legislated by the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604). This plan has been developed to ensure that the objectives of licensing are met by identifying the necessary institutional controls, participatory agency responsibilities, and key milestones in the licensing process. The plan contains the legislative basis for and a description of the licensing process for UMTRA sites. This is followed by a discussion of agency responsibilities and milestones in the process. The Plan concludes with a generic time line of this process. As discussed in Section 2.1, a custodial maintenance and surveillance plan will constitute the basis for a site license. The details of maintenance and surveillance are discussed in the Project Maintenance and Surveillance Plan (AL-350124.0000).

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**Plan for Implementing EPA standards for UMTRA sites**

DOE/UMTRA-163; 31 pp. (January 1984)

The Uranium Mill Tailings Radiation Control Act of 1978, authorizes the U.S. Department of Energy (DOE) to undertake remedial actions at 24 DOE-designated processing sites. The term "processing site," by statutory definition, means the inactive uranium mill or processing site and any other real property or improvement that is in the vicinity of the mill or processing site and is determined to be contaminated with residual radioactive materials derived from the mill or processing site. For purposes of this document, the inactive mill or processing site is referred to as the "processing site" and the other real property or improvement in the vicinity of such a site is referred to as a vicinity property. The purpose of the remedial actions is to stabilize and control the uranium mill tailings and other residual radioactive materials in a safe and environmentally sound manner. Remedial actions undertaken by DOE are to be accomplished (1) with the full participation of the affected states and Indian tribes, (2) in accordance with standards issued by the Environmental Protection Agency (EPA), and (3) with the concurrence of the Nuclear Regulatory Commission. This plan is designed to be a generic presentation on methodology that will be followed in implementing the EPA standards.

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### UMTRA Public Information Plan

DOE/UMTRA-184; 31 pp. (June 1984)

The Public Information Plan is intended to be used in conjunction with the Public Participation Plan to describe the U.S. Department of Energy plan for involving the public in the decision making process related to the Uranium Mill Tailings Remedial Action (UMTRA) Project. This project was authorized by Congress in the Uranium Mill Tailings Radiation Control of Act of 1978, Public Law 95-604. The act provides for a cooperative effort with affected states and Indian tribes for the cleanup of designated abandoned or inactive uranium mill tailings sites. The objective of the Public Information Plan of the UMTRA Project is timely and sufficient dissemination of factual information to promote understanding of the project by federal, state, and local officials, the news media, special interest groups, and the general public, and thereby to encourage informed participation in the project by the public and government officials. The act provides for public involvement in remedial action planning, with special consideration given to landowners, Indian tribes, and the states. According to the act, the Secretary of Energy will hold public hearings in the states where processing sites, vicinity properties, and disposal sites are located. Public participation in the UMTRA project will not, however, be limited to those mechanisms formally required by law. The public may also be involved informally through informational meetings, workshops, and local citizens' task forces.

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### Alternate Site Selection Process for UMTRA (Uranium Mill Tailings Remedial Action) Project Sites

DOE/UMTRA-200129-0007; JEGA/UMT-0788-0314; 22 pp. (June 1988)

The purpose of this document is to describe the guidelines and processes to be used by the U.S. Department of Energy (DOE) with input from the affected states and tribes, to select alternate disposal sites in compliance with each established cooperative agreement. This document supersedes two previous DOE documents, Criteria for Evaluating Disposal Sites (DOE, 1982) and Alternate Site Selection Process (ASSP) for Uranium Mill Tailings Remedial Action Project sites (DOE, 1986). This revision of the ASSP was prepared in response to the proposed groundwater protection standards that amend 40 CFR 192. The principal modifications are to the ASSP screening criteria for hydrological and geological conditions at candidate disposal sites. The revised screening and selection criteria will assist the project in selecting disposal sites where the probability of compliance with the proposed groundwater standards is high. The ASSP described in Section 2.0 consists of three phases: Phase 1 - designation of a search region; Phase 2 - preliminary screening of the designated search region; and Phase 3 - identification and evaluation of candidate sites. Section 3.0 discusses how the results of the ASSP will be reported. This process provides a technically sound and publicly defensible approach for identifying potentially suitable disposal sites.

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### UMTRA Project Surveillance and Maintenance Plan

DOE/UMTRA-350124; 173 pp. (January 1985)

The Project Surveillance and Maintenance Plan (PSMP) describes the procedures that will be used by the U.S. Department of Energy (DOE), or other agency as designated by the President of the United States to verify that inactive uranium tailings disposal facilities remain in compliance with licensing requirements and U.S. Environmental Protection Agency (EPA) standards for remedial actions. The PSMP will be used as a guide for the development of individual Site Surveillance and Maintenance Plans (SSMPs) (part of a license application) for each of the UMTRA Project sites. The PSMP is not intended to provide minimum requirements but rather to provide guidance in the selection of surveillance measures. For example, the plan acknowledges that groundwater monitoring may or may not be required and provides the guidance to make this decision. The SSMPs will form the basis for the licensing of the long-term surveillance and maintenance of each UMTRA project site by the Nuclear Regulatory Commission. Therefore, the PSMP is a key milestone in the licensing process of all UMTRA Project sites. The Project Licensing Plan describes the licensing process.

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**UMTRA (Uranium Mill Tailings Remedial Action) Project Site Management Manual**

DOE/UMTRA-40005 (Rev. 1); 97 pp. (October 1990)

The purpose of this manual is to summarize the organizational interfaces and the technical approach used to manage the planning, design development, National Environmental Policy Act (NEPA) compliance, engineering, and remedial action required to stabilize and control the designated Uranium Mill Tailings Remedial Action (UMTRA) Project sites. This manual describes the project's objective, participants' roles and responsibilities, the technical approach for accomplishing the objective, and planning and managerial controls to be used in performing the site work. The narrative follows the typical sequence of key project activities. A list of the acronyms used is presented at the end of the manual. The comparable manual for UMTRA project vicinity properties is the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601. Together, the two manuals cover the remedial action activities associated with UMTRA project sites. The UMTRA project objective is to stabilize and control the uranium mill tailings, vicinity property materials, and other residual radioactive materials at the designated sites in a safe and environmentally sound manner to minimize radiation health hazards to the public.

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**Uranium Mill Tailings Remedial Action (UMTRA) Project**

DOE/UMTRA-400124-0167; 53 pp. (September 1989)

The mission of the Uranium Mill Tailings Remedial Action (UMTRA) Project is explicitly stated and directed in the Uranium Mill Tailings Radiation Control Act of 1978. Title I of the act authorizes the U.S. Department of Energy (DOE) to undertake remedial action at designated inactive uranium processing sites and associated vicinity properties containing uranium mill tailings and other residual radioactive materials derived from the processing site. The purpose of the remedial actions is to stabilize and control such uranium mill tailings and other residual radioactive materials in a safe and environmentally sound manner to minimize radiation health hazards to the public. The principal health hazards and environmental concerns are (1) the inhalation of air particulates contaminated as a result of the emanation of radon from the tailing piles and the subsequent decay of radon daughters and (2) the contamination of surface and groundwater with radionuclides or other chemically toxic materials. This UMTRA Project Plan identifies the mission and objectives of the project, outlines the technical and managerial approach for achieving them, and summarizes the performance, cost, and schedule baselines which have been established to guide operational activity. The estimated cost increases by 15% if the schedule slips by 6 months.

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**UMTRA Project Management Plan**

DOE/UMTRA-400125; 100 pp. (January 1988)

The mission of the Uranium Mill Tailings Remedial Action (UMTRA) Project is explicitly stated and directed in the Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604, 42 U.S.C 7901 (hereinafter referred to as the Act). Title I of the Act authorizes the U.S. Department of Energy (DOE) to undertake remedial actions at 24 designated inactive uranium processing sites and associated vicinity properties containing uranium mill tailings and other residual radioactive materials derived from the processing sites. The Act, amended in January 1983, by Public Law 97-415, also authorizes DOE to perform remedial actions at vicinity properties in Edgemont, South Dakota. Cleanup of the Edgemont processing site is the responsibility of the Tennessee Valley Authority. This document describes the plan, organization, system, and methodologies used to manage the design, construction, and other activities required to cleanup the designated sites and associated vicinity properties in accordance with the Act. The plan describes the objectives of UMTRA, defines participant roles and responsibilities, outlines the technical approach for accomplishing the objectives, and describes the planning and managerial controls to be used in integrating and performing the project mission.

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**Integrated Project Management System Description**

DOE/UMTRA-400126; 83 pp. (March 1987)

The Uranium Mill Tailings Remedial Action (UMTRA) Project is a U.S. Department of Energy (DOE)-designated major system acquisition (MSA). To execute and manage the project mission successfully and to comply with MSA requirements, the UMTRA project office has implemented and operates an integrated project management system. The project office is assisted by the technical assistance contractor's project integration and control group in system operation. Each participant, in turn, provides critical input to system operation and reporting requirements. The project management system provides a uniform structured approach for integrating the work of project participants. It serves as a tool for planning and control, workload management, performance measurement, and specialized reporting within a standardized format. This system description presents the guidance for its operation. Appendixes 1 and 2 contain definitions of commonly used terms and abbreviations and acronyms, respectively.

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**Key Programmatic Steps and Activities for Implementing the Uranium Mill Tailings Remedial Action Project**

DOE/UMTRA-400129; 54 pp. (July 1985)

The Uranium Mill Tailings Radiation Control Act of 1978 was enacted based upon findings by Congress that (1) uranium mill tailings located at active and inactive sites present a hazard to the public; and (2) that protection of the public health, safety, and welfare and the regulation of interstate commerce require that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings. A general understanding of the steps leading to elimination of the hazards associated with designated uranium mill tailings sites and the parties involved in that effort are presented in this document. A representative schedule is also presented in this document to show both program sequence and activity interdependence. Those activities that have the most potential to influence program duration because of the significant amount of additional time that may be required include identification and selection of a suitable site, field data collection delays due to weather, actual acquisition of the designated or alternate disposal site, construction delays due to weather, and site licensing. This document provides an understanding of the steps, the sequence, the parties involved, and a representative duration of activities leading to remedial action and cleanup at the designated inactive uranium mill tailings sites.

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**U.S. Department of Energy Response to Standards for Remedial Actions at Inactive Uranium Processing Sites: Proposed Rule**

DOE/UMTRA-400501; 93 PP. (January 29, 1988)

The Title I groundwater standards for inactive uranium mill tailings sites which were promulgated on January 5, 1983, by the U.S. Environmental Protection Agency (EPA) for the Uranium Mill Tailings Remedial Action (UMTRA) Project, were remanded to the U.S. Environmental Protection Agency (EPA) on September 3, 1985, by the U.S. Tenth Circuit Court of Appeals. The court instructed EPA to compile general groundwater standards for all Title I sites. On September 24, 1987, EPA published proposed standards (Federal Register 52:6000-36008) in response to the remand. This report includes an evaluation of the potential effects of the proposed EPA groundwater standards on UMTRAP, as well as a discussion of the DOE position on the proposed standards. The report also contains an appendix that provides supporting information and cost analyses. To assess the impacts of the proposed EPA standards, this report summarizes the proposed EPA standards in Section 2.0. The next three sections assess the impacts of the three parts of EPA standards: Subpart A considers disposal sites; Subpart B is concerned with restoration at processing sites; and Subpart C addresses supplemental standards. Section 6.0 integrates previous sections into a recommendations section. Section 7.0 contains the DOE response to questions posed by EPA in the preamble to the proposed standards.

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**UMTRA Groundwater Contaminant Plume Ranking**

DOE/UMTRA-400640; 39 pp. (August 1988)

Containment plumes at Uranium Mill Tailings Remedial Action (UMTRA) Project sites were ranked to assist in Subpart B (i.e., restoration requirements of 40 CFR Part 192) compliance strategies for each site, to prioritize aquifer restoration, and to budget future requests and allocations. The rankings roughly estimate hazards to the environment and human health and, thus, assist in determining for which sites cleanup will provide the greatest benefits for funds available. The rankings are based on the scores that were obtained using the U.S. Department of Energy's (DOE) Modified Hazard Ranking System (MHRS). The MHRS and Hazard Ranking System consider and score three hazard modes for a site: (1) migration, (2) fire and explosion, and (3) direct contact. The migration hazard mode score reflects the potential for harm to humans or the environment from migration of a hazardous substance off a site by groundwater, surface water, and air; it is a composite of separate scores for each of these routes. For ranking the containment plumes at UMTRA Project sites, it was assumed that each site had been remediated in compliance with U.S. Environmental Protection Agency standards and that relict contaminant plumes were present. Therefore, only the groundwater route was scored, and the surface water and air routes were not considered. Section 2.0 of this document describes the assumptions and procedures used to score the groundwater route, and Section 3.0 provides the resulting scores for each site.

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**Moisture Content and Unsaturated Conditions in UMTRA Project Radon Barriers**

DOE/UMTRA-400656; 37 pp. (December 1988)

A typical Uranium Mill Tailings Remedial Action (UMTRA) Project disposal facility consists of uranium tailings and other contaminated materials covered by a 3- to 6-ft thick radon barrier and 6 in. of filter sand, overlain by 1 ft of erosion-protection riprap. To comply with the proposed U.S. Environmental Protection Agency groundwater protection standards applicable to the UMTRA Project, groundwater concentration limits of hazardous constituents cannot be exceeded at the point of compliance, which is the downgradient limit of the waste management area. The typical radon barrier has a saturated hydraulic conductivity of approximately 1 X 10(E-7) centimeters per second. Long-term seepage rates from a disposal facility with an unsaturated radon barrier may permit the concentration limits to be met at the point of compliance. Field studies were undertaken to measure the percent saturation and the relation of percent saturation to soil tension and to predict the hydraulic conductivity as a function of percent saturation in radon barriers at three UMTRA Project disposal facilities that have been completed for up to two years. Presently typical covers have been completed at the Shiprock, Clive, and Burrell sites, and they are planned or under construction at the Ambrosia Lake, Green River, Lakeview, Mexican Hat, Slick Rock, and Tuba City sites.

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U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**Performance Assessment of Select Covers and Disposal Cell Compliance with EPA (Environmental Protection Agency) Groundwater Standards**

DOE/UMTRA-400657; 18 pp. (June 1989)

This document describes the technical approach to the assessment of the performance of a full component topslope cover, three sideslope covers, and hence the way in which a Uranium Mill Tailings Remedial Action (UMTRA) Project disposal cell complies with the U.S. Environmental Protection Agency (EPA) groundwater protection standards.

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U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**Sodium-Amended Radon Barrier: Findings of the Special Study**

UMTRA-DOE/AL-400651.0000; 53 pp. (October 1988)

This report describes the findings of a special study on the use of sodium to amend radon barriers on stabilized tailings piles for the Uranium Mill Tailings Remedial Action (UMTRA) Project. The study was undertaken because adsorbed sodium in clay-rich soils reduces the hydraulic conductivity of those soils compared with nonsodic soils. This phenomenon would facilitate efforts to comply with proposed groundwater standards (40 CFR 192) by greatly reducing the amount of water that can pass through the radon barrier, contact the tailings, and eventually transport contaminants to the underlying groundwater. The study goals were to (1) evaluate the feasibility of this approach, (2) identify the levels of sodium needed to achieve the desired effect, (3) address the longevity and reversibility of the phenomenon, (4) identify ways to construct a sodium-amended radon barrier, and (5) recommend policies and continuing actions on the use of this approach. A principal contributor to the study was Dr. George O'Connor of New Mexico State University, who reviewed the relevant literature and supervised analyses of the samples from three UMTRA sites. His final report, with comments by Bimal Mukhophadyay of the Jacobs Engineering Group (the UMTRA technical assistance contractor), is included as Appendix A. Triaxial permeability testing is under way at Chen and Associates; final results were unavailable at the time this report was published. During the study, the technique of amending the radon barrier with sodium was determined to be feasible for use on the UMTRA Project. Hydraulic conductivities of 10(E-9) or less could be achieved using soils that have high concentrations of smectite clays, if (a) many sodium ions are adsorbed on the clay particles and (b) if soluble salts are largely absent from the soil profile. A radon barrier with an exchangeable sodium percentage greater than 25% and with an electrical conductivity of less (preferably much less) than 10 milli-equivalents per liter would have the desired effect. There are difficulties in finding the appropriate materials and constructing the barrier at any given site. The trademark product Claymax uses sodium-induced dispersion/deflocculation to achieve the same effect and is a commercially available, readily transportable, and purportedly manageable product. If Claymax lives up to expectations, than the use of sodium amendments as described in this report may be unnecessary. The report recommends that further study on sodium-amended radon barriers be given low priority in favor of continued studies of Claymax. The study may become of great value, however, if for any reason Claymax loses its attractiveness as the principal material for reducing the hydraulic conductivity of UMTRA Project tailings pile covers.

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U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**Effect of Freezing and Thawing on UMTRA Covers**

UMTRA-DOE/AL Report; 59 pp. (October 1988)

This report presents the results of a study undertaken to determine the effects of freezing and thawing on the hydraulic conductivity of a fine grained infiltration barrier for Uranium Mill Tailings Remedial Action (UMTRA) Project tailings piles. It proposes a method for determining the frost depth at UMTRA Project sites and presents recommendations and conclusions. The results of limited laboratory test data indicate that infiltration barriers should be protected from freezing to prevent an increase in their hydraulic conductivity. Thermal cracking also might degrade cover performance. It is concluded that a degree of frost protection should be provided for infiltration barriers at sites where frost could penetrate the cover. The method and degree of protection depends on site-specific conditions.

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U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**UMTRA (Uranium Mill Tailings Remedial Action) Project Remedial Action Planning and Disposal Cell Design to Comply with the Proposed EPA Standards (40 CFR Part 192)**

UMTRA-DOE/AL-400503.0000; 131 pp. (January 1989)

In September 1987, the U.S. Environmental Protection Agency (EPA) proposed remedial action standards that address groundwater protection requirements applicable to the Uranium Mill Tailings Radiation Control Act Title I sites. The U.S. Department of Energy (DOE) supports the intent of the proposed standards to protect human health and the environment. Final standards are not likely to be published until Spring 1989. To proceed with the Uranium Mill Tailings Remedial Action (UMTRA) Project, DOE adopted and is working with this interim policy statement: "During the period before promulgation of the final standards, DOE intends to comply with Subparts A and C of the proposed standards as they apply to disposal sites and the design and construction of disposal cells. The provisions of Subparts B and C, as they apply to groundwater remediation, will be complied with following promulgation of the final standards." DOE has provided comments on the proposed standards and has undertaken numerous special studies and design reviews directed toward compliance with them. This report describes the results of the special studies and the way in which remedial action plans, disposal cell designs, and groundwater compliance strategies have been, are, and will be implemented by DOE in light of the requirements of the EPA groundwater protection standards. This report describes the special studies and their design and policy implications for the UMTRA Project. DOE has defined a series of possible disposal cell layouts, perimeter dike details, and disposal cell covers that lead to compliance with the proposed standards and achieve the following design objectives or criteria: (1) a design life of 1000 years when achievable, and of 200 years, at any rate; (2) control of the dispersion of tailings and contaminated materials and prevention of their use by humans and animals; (3) minimum reliance on active human maintenance; and (4) control of seepage of contaminants from the disposal facility when required to achieve compliance with groundwater standards. DOE estimates that the additional cost of Subpart A compliance could be as much as $60 million. Subpart B compliance could cost between 300 million and one billion dollars.

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U.S. Department of Energy, Albuquerque Operations Office, Uranium Mill Tailings Remedial Action Project Office, Albuquerque, NM

**Vegetative Covers: Special Study**

UMTRA-DOE/AL-400642.0000; JEGA/UMT-1288-0525; 59 pp. (November 1988)

This report describes the findings of a special study on the use of vegetative covers to stabilize tailings piles for the Uranium Mill Tailings Remedial Action (UMTRA) Project. The principal rationale for using plants to stabilize tailings piles is that it would establish a dynamic system for controlling water balance. Specifically, vegetation would be used to intercept precipitation and allow it to transpire to the atmosphere, rather than drain into the tailings and mobilize contaminants. This would facilitate compliance with groundwater standards proposed by the U.S. Environmental Protection Agency for the UMTRA Project. The goals of the study were to: (1) evaluate the feasibility of using vegetative covers on UMTRA Project piles, (2) define the advantages and disadvantages of vegetative covers, and (3) develop general guidelines for their use when it seems feasible. The principal method for the study was to analyze and apply to the UMTRA Project the results of research programs on vegetative covers at other U.S. Department of Energy waste management facilities. The study also relied on observations of existing stabilized piles at UMTRA Project sites where natural vegetation is growing on the rock-covered surfaces. Water balance and erosion models also were used to quantify the long-term performance of vegetative covers on two UMTRA sites where such covers were used. Elements of the design and construction of the vegetative covers at these two sites are discussed in the report. The principal finding of the special study is that vegetative covers are appropriate for use on top slopes of stabilized UMTRA Project tailings piles. A properly developed plant community (and associated soil layer) will maintain long-term control of the water balance of the pile, greatly restricting the amount of water that can contact the tailings and transport contaminants to underlying groundwater. The principal impediment to the broader use of vegetative covers is a lack of precision in the ability to quantify performance with respect to water balance and gully formation. These concerns may be resolved in the near future by using vegetative covers in combination with other components that facilitate performance, for instance the product Claymax, a bentonite clay layer sandwiched between geotextiles. The report provides several design concepts that can be used for vegetative covers on stabilized piles. However, it is critical that certain elements in the cover (e.g., soil type, soil thickness, plant species, and surface treatments) be tailored to the environmental conditions at each site.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Annual Status Report on the Uranium Mill Tailings Remedial Action Program**

DOE/EM-0001; 44 pp. (December 1989)

This eleventh annual status report summarizes activities of the Uranium Mill Tailings Remedial Action (UMTRA) Project undertaken during FY 1989 by the U.S. Department of Energy and other agencies. Project goals for FY 1990 are also presented. Assessment and remedial actions to control uranium mill tailings and other residual radioactive materials at 24 inactive uranium processing sites and associated vicinity properties are summarized. UMTRA completed the following 13 processing site remedial actions: (1) 98% of Lakeview, Oregon; (2) 100% of Salt Lake City, Utah; (3) 100% UMTRA portion of Spook, Washington; (4) 88% of Riverton, Wyoming; (5) 71% of Tuba City, Arizona; (6) 62% of Green River, Wyoming; (7) 63% of Durango, Colorado; (8) 31% of Mexican Hat, Utah and (9) Monument Valley, Arizona; (10) 14% of Ambrosia Lake, New Mexico; (11) 10% of Rifle, Colorado and (12) Grand Junction, Colorado; and (13) 8% of Monument Valley, Arizona. Remedial action contracts were initiated on 737 vicinity properties for eight designated sites, and inclusion decision activities were completed on a total of 340 vicinity properties. Significant progress was made on completion of remedial action of complex commercial properties in Durango, Colorado. National Environmental Policy Act documents were completed for Mexican Hat, Utah; Monument Valley, Arizona; and Spook, Wyoming. Remedial action plans (RAPs) were completed for Mexican Hat, Utah; Monument Valley and Tuba City, Arizona; Rifle, Colorado; and Spook, Wyoming. A draft RAP was completed for Maybell, Colorado. Appendixes to the report include program funding, figures and tables, comments from affected states and tribes, and photographs of remedial actions.

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**Uranium Mill Tailings Remedial Action Amendments Act of 1988**

U.S. Senate Report 100-543, Calendar No. 984, Introduced in the Senate, One Hundredth Congress, Second Session, September 23, 1988; 13 pp. (1988)

The Committee on Energy and Natural Resources reported favorably on the Uranium Mill Tailings Remedial Action Amendments Act of 1987 (Senate Bill 1991) with some amendments, the principal one being to change the 1987 date to 1988. The purpose of this bill is to authorize the Secretary of the Interior to transfer lands under the jurisdiction of the Bureau of Land Management to the Department of Energy for permanent surveillance and maintenance of remediated mill tailings as required by the Uranium Mill Tailings Radiation Control Act of 1978. The bill also extends the authority of the Secretary of Energy to perform remedial action at designated uranium mill tailing sites and vicinity properties until September 30, 1994. The authority to perform groundwater restoration activities is extended without limitation.

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**Uranium Revitalization, Tailings Reclamation and Enrichment Act of 1988**

U.S. House Resolution HR-4934, Introduced in the House of Representatives, One Hundredth Congress, Second Session, June 28, 1988; U.S. House Resolution HR-4975, Introduced in the House of Representatives, One Hundredth Congress, Second Session, June 30, 1988; 85 pp. (1988)

House Resolution HR-4934 and HR-4975 are drafts of a bill to provide for a viable domestic uranium industry; to establish a program to fund reclamation and other remedial actions with respect to mill tailings at active uranium and thorium sites; to establish a wholly-owned government corporation to manage the nation's uranium enrichment enterprise, operating as a continuing, commercial enterprise on a profitable and efficient basis; and for other purposes.

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**Grand Junction Vicinity Properties Supplemental Standards Applications**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 323-330) (April 1990)

The Environmental Protection Agency Standards for Remedial Action at Inactive Uranium Processing Sites (40 CFR 192) set forth the guidelines for remediation of vicinity property sites. Part of these regulations include supplemental standards whereby the flexibility was created to not clean up properties if certain conditions were met. To meet the criteria established, a formal process has been developed to submit an Application for Supplemental Standards for review and concurrence by the individual state, the Nuclear Regulatory Commission, and the Department of Energy. This poster summarizes the past 15 such applications from the Grand Junction Vicinity Properties in Colorado.

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**Dewatering of Tailings Disposal Cell at Durango, Colorado**

CONF-9004181 (Vol. 2); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp.; (pp. 125-127) (April 1990)

Located 3.5 miles from the former uranium processing mill, the Durango, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) Project disposal cell will contain over 2.3 million cu yd of low-level radioactive material. In the fall of 1988, a line of seepage emerged along the eastern slope of the disposal cell while it was under construction. Construction water and precipitation were viewed as the source for an estimated 16-20 million gal of drainable water. By June 1989, evaporite crystals covered an extended area of the seepage. The saturated soils and seepage prevented placement of cover material on the eastern face of the disposal cell. The engineered fill contained fine-grained sands from the uranium milling process. During relocation of the tailings, over 96% compaction of the sandy material was achieved. To dewater this type of fill, several alternatives were considered: (1) a toe trench with an ejector line to enhance dewatering in the center of the disposal cell, (2) an eductor system containing 150 wells, (3) a deep-well system of 54 wells with submersible pumps, and (4) horizontal drain lines. To allow construction to continue, a smaller dewatering system with 17 pumping wells and 10 observation wells was installed in the lowest portion of the eastern zone of the cell. Low flow rates from the wells led to a decision to install a toe trench at the base of the eastern slope and discontinue pumping. The remainder of the contaminated material from the Durango site was meanwhile placed in the cell, allowing placement of the remaining layers of the disposal cell cover. The toe trench prevented reappearance of the seep. Perched water was discovered on a layer of low permeable soil while test pits for the toe trench were being dug. Subsequently, estimates of drainable water were revised downward to 2-3 million gal (of which one million gal had been removed) as of April 1990, by the smaller dewatering system and the toe trench. Dewatering work at the disposal cell continues. Modeling studies are being performed to predict the long-term drainage performance of the toe trench and to predict the length of time the trench will need to be operated. Concurrently, groundwater compliance strategy and site characterization are being finalized under the UMTRA contract.

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**Determination of the Probability for Radioactive Materials on Properties in Monticello, Utah**

ORNL/TM-11682; 231 pp. (February 1991)

The uranium mill site at Monticello, Utah, built by the U.S. government in 1942 and operated until January 1, 1960, was declared surplus property and accepted into the Surplus Facilities Management Program (SFMP) in 1981. Throughout the mill's operation, area residents obtained tailings from the mill and used them as fill material and as aggregate in mortar and concrete. Radioactive

material also migrated into the environment due to wind erosion of the tailings pile. Under direction from the U.S. Department of Energy, the Oak Ridge National Laboratory (ORNL) Grand Junction, Colorado-based Pollutant Assessments Group developed 5- and 7-pCi/g lines (based on concentrations of Ra-226 in soil) to define the boundaries of windblown contamination from the Monticello Mill site. Because radiological survey data indicated that some properties outside the windblown area exceed DOE guidelines for remedial action, ORNL was directed to provide detailed sample analysis data for those properties and to prepare a statistical plan to estimate the number of unassessed properties outside the windblown boundaries that may require remedial action. This report presents that statistical plan and the conclusion that 21% of Monticello properties outside the lines of windblown contamination may be eligible for SFMP inclusion.

# URANIUM MILL TAILINGS MANAGEMENT

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**Tailings Management at Nabarlek**

CONF-8910529 (Vol. 1); Proceedings of the 1989 Australian Mining Industry Council Environmental Workshop, Ballarat, Australia, October 1989. Australian Mining Industry Council, Dickson, ACT, Australia, Vol. 1, 158 pp.; (pp. 11-19) (1989)

Nabarlek is the first open-cut mine to have its tailings placed directly in the pit from which the ore was won. An account is given of the continual reassessing and upgrading of the operations and technology in relation to tailings disposal. The main decision was to change from subaqueous to a semidry deposition, using geotextile laying and a free-draining gravel or cobbles for covering. Some of the lessons learned during this operation are enunciated.

527
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**Modelling the Effects of Uranium Mine Tailings on a Permafrost Environment**

INIS-mf-12807; CONF-880943; Uranium and Electricity: The Complete Nuclear Fuel Cycle, K.H. Talbot and V.I. Lakshmanan (eds.), Proceedings of an International Symposium, Saskatoon, Canada, September 18-21, 1988, 411 pp.; (pp. 2.33-2.39) (1988)

A model has been established to describe and predict the effects of uranium mine tailings on the hydrological and thermal environments of the Keewatin, where permafrost is a significant condition to be managed. The model couples the water and energy fluxes to melt snow, evaporate water, and thaw the active layer. The tailings can be dry or submerged. They can be covered with a variety of materials. Model parameters are based on field data appropriate to a remote environment.

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**Provincial Program for the Environmental Regulation of Uranium Mining in Saskatchewan**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 461-470) (1986)

This paper describes the environmental licensing and monitoring work of the Mines Pollution Control Branch of Saskatchewan. The history of the Saskatchewan uranium industry is recounted, and information provided on past, present and future operations. The emphasis is on tailings and on the prevention of water pollution. The procedure for licensing new operations or significant expansions requires an environmental impact assessment, and public hearings may be needed. Once a mine or mill application is approved, the applicant must sign a lease containing specific requirements relating to environmental monitoring. The trend with regard to decommissioning is to plan for it from the very beginning.

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**Recommendations to the NRC for Soil Cover Systems over Uranium Mill Tailings and Low-Level Radioactive Wastes - Volume 1: Identification and Ranking of Soils for Disposal Facility Covers**

NUREG/CR-5432 (Vol. 1); 56 pp. (February 1991)

The U.S. Army Engineer Waterways Experiment Station (WES) provides recommendations to the U.S. Nuclear Regulatory Commission (NRC) for the selection, placement, compaction, testing, and acceptance of soils proposed to be placed in cover systems over uranium mill tailings and low-level radioactive wastes. The recommendations from WES are contained in three volumes of NUREG/CR-5432. Volume 1 identifies the various soil types and engineering properties that are needed to fulfill important soil cover functions. The identified soils are then ranked according to their capability to perform the low-permeability and filter and drainage functions.

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**Recommendations to the NRC for Soil Cover Systems over Uranium Mill Tailings and Low-Level Radioactive Wastes - Volume 2: Laboratory and Field Tests for Soil Covers**

NUREG/CR-5432 (Vol. 2); 73 pp. (February 1991)

The U.S. Army Engineer Waterways Experiment Station (WES) has provided recommendations to the U.S. Nuclear Regulatory Commission for the selection, placement, compaction, testing, and acceptance of soils proposed to be placed in cover systems over uranium mill tailings and low-level radioactive wastes. The recommendations from WES are contained in three volumes of NUREG/CR-5432. Volume 2 provides recommendations for conducting pertinent laboratory and field tests to ensure acceptable soil-cover performance.

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**Recommendations to the NRC for Soil Cover Systems over Uranium Mill Tailings and Low-Level Radioactive Wastes - Volume 3: Construction Methods and Guidance for Sealing Penetrations in Soil Covers**

NUREG/CR-5432 (Vol. 3); 83 pp.. (February 1991)

The U.S. Army Engineer Waterways Experiment Station (WES) provides recommendations to the U.S. Nuclear Regulatory Commission (NRC) for the selection, placement, compaction, testing, and acceptance of soils proposed to be placed in cover systems over uranium mill tailings and low-level radioactive wastes. The recommendations from WES are contained in three volumes of NUREG/CR-5432. Volume 3 covers recommendations from WES on proper field construction methods, including guidance on quality control testing and inspections. Recommendations are given for sealing penetrations (e.g., observation wells) that are required to penetrate covers for environmental monitoring of disposal facility performance.

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**The Hydrogeochemistry of Four Inactive Tailings Impoundments: Perspectives on Tailings Pore-Water Evolution**

CONF-8712168; Proceedings of a National Symposium on Mining, Hydrology, Sedimentology, and Reclamation, Lexington, KY, December 7-11, 1987, 441 pp.; (pp. 253-261) (1987)

Extensive hydrogeochemical investigations are currently underway at three inactive tailings impoundments in Canada. These programs include detailed measurements of pore-water and gas-phase geochemistry through the vadose zone and the groundwater zone. An extensive piezometer network has been installed at each location to monitor the groundwater flow regime. All of the impoundments studied have been inactive for 15 to 25 years, sufficient time for extensive tailings pore-water evolution. The study areas include (1) a very high-sulfide impoundment; (2) a low-sulfide, high-carbonate impoundment; (3) a low-sulfide, very low-carbonate impoundment; and (4) a moderately high-sulfide impoundment. The pore water at each of the sites has evolved in a distinctly different and characteristic manner, representing broad styles of tailings pore-water evolution. At the high-sulfide impoundment the oxidation of sulfide minerals has resulted in low pH, high redox potential conditions, with Fe-2 concentrations in excess of 60,000 mg/l. At a depth of about 40 cm, a 10-cm-thick layer of ferrous and calcium sulfate minerals has precipitated. This hardpan layer limits the downward movement of O-2 and infiltrating pore waters. As a result, the pore water chemistry, both above and below the hardpan layer, has remained relatively unchanged over the past 10 years. The low-sulfide, high-carbonate tailings are sufficiently well buffered that no low pH conditions are present. The high-pH conditions limit the concentrations of the metals released by sulfide mineral oxidation to levels that are two or three orders of magnitude less than is observed at the high-sulfide site. Pore waters at the low-sulfide, low-carbonate site were sampled by other researchers from the University of Waterloo.

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**Problems Resulting from Reclamation Work in Uranium Industry Areas in the GDR**

INIS-mf-12820; CONF-9010350; Chemical Mining and Processing Methods - Session N, Proceedings of a Science and Technology in Mining Conference, Pribram, Czechoslovakia, October 15-19, 1990, 502 pp.; (pp. 479-486) (1990)

Uranium ore mining and processing organizations are facing the task of reclaiming dumps, storage yards, settling pits and areas where production was situated. The main emphasis is placed on radiation protection. Dumps are covered with a 1-2 m layer of inert material, settling pits with a layer 5 m thick; the use of plastic layers is being considered. It is projected that the release of harmful substances into the atmosphere or to groundwater may continue for several centuries. The reclamation and future use of the sites in accordance with laws governing the environment are discussed in general terms.

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**Licensing of Uranium Mine and Mill Waste Management Systems**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 432-438) (1986)

Systems for managing wastes from uranium mining facilities are subject to regulatory control by the Canadian Atomic Energy Control Board (AECB). This paper describes the primary objectives, principles, requirements, and guidelines the AECB uses in regulating waste management activities at uranium mining facilities. It also provides an understanding of the licensing process used by the AECB.

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**Stability of Natural Barriers Exposed to Uranium Mill Wastes**

INIS-mf-12807; CONF-880943; Uranium and Electricity: The Complete Nuclear Fuel Cycle, K.H. Talbot and V.I. Lakshmanan (eds.), Proceedings of an International Symposium, Saskatoon, Canada, September 18-21, 1988, 411 pp.; (pp. 2.1-2.6) (1988)

Till, silt, clay, peat and soils modified with commercial bentonite can be considered for use as barriers to seepage from uranium mill waste impoundments. Hydrogeochemical processes including dissolution, reactions, replacement reactions, precipitation reactions and ion exchange may alter the physical characteristics of the barrier materials. Similarly, the permeability of the barrier may be altered due to physical changes such as swelling, development of cracks or fissures, or piping. This paper explores how physical and geochemical processes may affect the performance of natural soil barriers.

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**Acidification and Radionuclide Leaching in Unsaturated Uranium Mill Tailings**

INIS-mf-12730; CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 538-547) (1986)

The results are presented of a 7-year leaching study on tailings that were approximately 20 years old, fresh tailings, and fresh tailings solidified by a proprietary process. The main dissolved ions in the leachates from the 20-year-old tailings were hydrogen, iron and sulphate. The concentrations of these ions and the leaching patterns of conductivity and total dissolved solids concentrations suggest that the acidification rate is independent of the water addition rate in these unsaturated tailings, as would be expected if pyrite oxidation is bacterially controlled and follows zero order kinetics. In the old tailings, 0.8% of the Ra-226 in the lysimeters with the higher water addition rates was leached during this study, compared with only 0.02% of the Ra-226 in the lysimeters with the lowest water addition rate. Ra-226 levels in the low-rate leachate generally decreased over the 7 years from 3.7 Bq/l (15 pCi/l). Ra-226 levels in the high-rate leachate remained relatively constant at about 0.74 Bq/l (20 pCi/l) for the first 3 years, then increased to peak at 19 Bq/l (514 pCi/l) after 6 years. The pH of leachate from the solidified fresh tailings lysimeters remained at about 11.7 during the first two years, then declined to reach 7.1 at the end of the study. The results suggest that the solidification process merely delays the commencement of pyrite oxidation and does not prevent it from eventually occurring.

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**Radium-226 in Snowshoe Hares Near Uranium Mine Tailings**

MIC-90-02552; MRL-89-106(TR); 18 pp. (1989)

The extensive inactive tailings deposits around the uranium mines near Elliot Lake, Ontario, are of different ages and have received differing treatments after being decommissioned. These tailings are to be returned to nature after rehabilitation and eventually will be areas of wildlife management. This report presents the levels of radium-226 (Ra-226) in bones (femur and tibiofibula) and stomach contents of hares trapped near uranium tailings and on control sites, calculates the average internal skeletal radiation dose due to Ra-226, and discusses the problems of calculating the transfer coefficient of the Ra-226 from food to hare.

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**Effects of Various Tailings Covers on Radon Gas Emanation from Pyritic Uranium Tailings**

CONF-8712168; Proceedings of a National Symposium on Mining, Hydrology, Sedimentology, and Reclamation, Lexington, KY, December 7-11, 1987, 441 pp.; (pp. 99-104) (1987)

Radon emanation studies were carried out at an inactive pyritic uranium tailings site in Elliot Lake, Ontario, Canada, to evaluate the effects of various existing dry and wet covers on radon flux rates. Measurements were taken using activated charcoal cartridges for various surface covers consisting of (1) bare, vegetated, acidophilic moss with high degrees of water saturation; (2) compacted crushed rock and gravel; and (3) winter snow. The results showed that at a given site there was no significant difference in radon emanation rates between various tailings covers and bare tailings. In particular, no increase in radon emanation rates from vegetated areas compared to bare tailings was observed. Radon emanation rates varied spatially depending on tailing grain size, porosity, moisture content, and pressure- and water-table variations. The emanation rates were higher for tailings with low water contents than those for wet and moss covered tailings.

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**Geochemical Evolution of Inactive Pyritic Tailings in the Elliot Closed Uranium District**

Dissertation Abstracts International 47(05-B):1898 (1986)

Geochemical data on the groundwaters and solids from three inactive uranium tailings impoundments in the Elliot Lake district of Ontario indicate that oxidation of pyrite occurring in the shallow part of the vadose zone is causing severe acidification of the tailings groundwater. A two-layer hydrochemical zonation has developed in which low-pH infiltration with high concentrations of SO4, Fe, and heavy metals is gradually migrating downward at 0.2 and 2 meters per year. This causes the downward displacement of the original mill process water (which has neutral pH). The oxidation process involves oxidation of pyrite by Fe(III), but is driven by entry of atmospheric oxygen into the shallow vadose zone in the tailings. The heavy metals Co, Ni, Zn, Pb, and Cu are solubilized in the pore waters of the vadose zone from acidification by pyrite oxidation. Concentrations of Pb are limited by the PbSO4 precipitation in zones of the tailings affected by pyrite oxidation. The relative depths of penetration of the heavy metals in the tailings follows the sequence: Cu, Pb, Zn, Ni = Co = Fe, which is similar to the sequence of sorption of these metals onto the most active sorbing geological materials in the tailings. Batch and column experiments were conducted on samples of fresh tailings to study the pH and acid neutralization processes. Results showed that the tailings have a significant capacity to neutralize acidity under low-pH conditions, and Ph buffering in the high-pH range exceeds that predicted on the basis of the carbonate mineral content. Application of an equilibrium geochemical model, ADNEUT, to the column results predicts a sequence of equilibrium pHs in the effluent similar to the experimental data: pH = 6.5 (calcite), pH = 5.8 (siderite), and pH = 4.48-4.28 [Al(OH3)]. ADNEUT was also used to simulate the evolution of the groundwater geochemistry currently observed in the Nordic Main tailings. Mass-balance calculations indicate that the vadose zone contains sufficient pyrite for the generation of high-Fe and low-pH groundwater to continue for a time period of several decades to several hundred years. Although at present only a small amount of the Nordic Main and West Arm tailings areas has become acidic through the entire tailings thickness, because of the potential for continued acid production, the impact of this seepage on groundwater beneath the tailings and eventually on nearby stream or lake water warrants investigation.

540

I.R. Duffield and T.A. Ward, Institution of Engineers, Canberra, Australia

**Rehabilitation Programme for the Mary Kathleen Uranium Mine**

CONF-8904367; Proceedings of the National Conference for Institution of Engineers, Perth, Australia, April 10-14, 1989, 491 pp.; (pp. 462-467) (April 1989)

The Mary Kathleen uranium deposit was located in the North West region of the state of Queensland, Australia. It was discovered in 1954 and mined in two phases for a total of twelve years between 1958 and 1982. In October 1982, operations at the site ceased with the deposit virtually exhausted and all contractual commitments completed. From the outset, a site-specific approach was adopted in developing the rehabilitation plan. Experiences from other sites were evaluated, but were adopted only if appropriate for the Mary Kathleen site. 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. The rehabilitation program commenced in mid 1982 and was completed in late 1985. Results of monitoring provided a strong basis for confidence that the objectives of the plan have been met, and allowed for the relinquishment of all the remaining mining leases in August 1987.

541

T.J. East, R.F. Cull, A.S. Murray, and K. Duggan, Alligator River Research Institute, Jabiru, Northern Territory, Australia; Division of Water Resource Research, Canberra, Australia; Kupang NTT, Indonesia

**Fluvial Dispersion of Radioactive Mill Tailings in the Seasonally-Wet Tropics, Northern Australia**

Fluvial Geomorphology of Australia, F.R. Warner (ed.). Academic Press Australia, Sydney, 373 pp.; (pp. 303-322) (1988)

Erosion of tailings at the Northern Herculaes mine at Moline, abandoned in 1972, has resulted in large present-day input - up to 90g/l X 10(E-1) - of radioactive sediments into local watercourses after the failure of containment bunds. This has been used as an analogue for predicting the possible fluvial dispersion of mine sediments at existing and future uranium mines in this region; for example, it is helping to formulate rehabilitation policies at Ranger. The downstream dispersal patterns of radioactive tailings is controlled by the nature of sedimentary environments, the properties of tailing sediments which affect transport and the dilution of flow and sediment from incoming tributaries. A generally consistent relationship exists between the type of sedimentary floodplain environment and the surface gamma dose rates. While dose rates are shown to decrease with distance downstream from the source, there is a tendency for fine particles to be more radioactive.

542

T.V. Edgar, Colorado State University, Fort Collins, CO

**Moisture Movement in Nonisothermal Deformable Media (Uranium Urban Tailings)**

Dissertation Abstracts International 44(08-B):2502-2795 (1983)

Many inactive uranium mill tailings impoundments currently exist in the United States. One facit of the U.S. Department of Energy reclamation plan for these sites is to enclose the impoundments with a cover. Several cover options are available, including thick and thin soil covers, synthetic covers, and layers of asphalt. Placement of any cover material could cause the water content of the tailings to change as a result of changes in the evaporation and infiltration rates. Because the state of stress of the soil is a function of its water content, these changes could cause the surface of the impoundment to settle and, thus, affect the performance of the liner material. This report investigates the effects of changing mechanical and fluid stresses on deformable media. A set of one dimensional equilibrium and balance equations for both two- and three-phase soils are developed based on a coordinate system which is defined by the soil solids. This analysis is based on the concepts of continuum thermomechanics and the theory of mixtures. A significant result of this analysis involves the natural importance of the stress state variables investigated by Fredlund and Morgenstern (1976) to the balance equations. A finite difference model was developed to solve the three coupled nonlinear partial differential equations which permits the study of the effects of liquid, gas and heat flows on the deformation of the soil. A set of constitutive relationships were selected which are compatible with a wide range of soil materials, including uranium tailings mixtures and Yolo light clay. Comparison shows excellent correlation between both vertical infiltration into a dry soil and saturated consolidation. A series of example problems were selected to analyze the effects of varying the soil and environmental parameters. Four significant cases were (1) drainage of an originally saturated soil, (2) consolidation of a partially saturated soil as a result of placement of a cover, (3) the effect of a low permeability layer on drainage, and (4) the effects of soil drying and crusting on evaporation.

543

EG&G Idaho, Inc., Idaho Falls, ID

**Uranium Task Force Final Report**

EGG-LLW-9599; 72 pp. (March 1991)

Site-specific data on the management of uranium of 17 facilities have been assembled and analyzed to develop a comprehensive report on uranium processes, treatment, storage, and disposal on a Department of Energy (DOE)-wide basis. By integrating a variety of waste generation sources,

treatment processes, storage facilities, and disposal options, this waste management system study aims to effectively characterize and evaluate the performance and effectiveness of the total DOE system for the management of uranium, as well as the individual sites.

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Ford, Bacon and Davis Utah, Inc., Salt Lake City, UT; Sandia National Laboratories, Albuquerque, NM

**Reduction of Radon Daughter Concentrations in Structures**

DOE/UMTRA-189; 107 pp. (December 1982)

A structure was identified in Salt Lake City wherein uranium mill tailings had been used in the construction and where unusually high levels of radon daughter concentrations (RDCs) existed. The physical and radiological characteristics of the structure were assessed. Ventilation techniques were investigated to assess their effectiveness in reducing RDCs. A preferred set of equipment was identified, installed in the structure, and operated to reduce RDCs. Parametric studies were conducted to determine if supplying fresh air or recirculating air through electrostatic precipitators is more effective in reducing RDCs. Fresh air was found to be more effective in reducing RDCs. RDCs have been reduced to levels at or near the target of 0.03 pCi/l working level under optimal ventilation conditions. Natural gas consumption with the new equipment is about 39% higher than with the original equipment. Electrical energy usage and electrical demand are, respectively, 50% and 44% higher with the new equipment than with the original equipment.

545

G.W. Gee, S.R. Peterson, and B.E. Opitz, Pacific Northwest Laboratory, Richland, WA; International Atomic Energy Agency, Vienna, Austria

**Optimization of Linings for Prevention of Radium Dispersion from Tailings**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

Liners, either natural or synthetic, are becoming a common feature of uranium tailings impoundments. Their design has been generally for the hydraulic isolation of tailings from surroundings, and in most cases they have not been designed for the selective containment of radium. Recently, however, some attention has been paid to designing and testing liners that have selective isolation capabilities for certain radionuclides, including radium. In this chapter, the design features of liners for hydrological and chemical isolation of tailings are reviewed. Included are discussions of both natural and synthetic liner systems for hydrological isolation and a neutralizing chemical barrier that has been proposed to reduce radium migration from tailings ponds.

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H. Geppert, J. Kuper, H. Graul, and G.A. Stache, Steinkohlen-Elektrizitaet AG, Kernenergie GmbH, Essen, Federal Republic of Germany; Urangesellschaft GmbH und Company KG, Frankfurt am Main, Federal Republic of Germany; AGU GmbH, Oberursel, Federal Republic of Germany; Bundesministerium fuer Forschung und Technologie, Bonn, Federal Republic of Germany

**Survey and Preliminary Concept for Reclamation of Industrial Waste at the Site of the Uranium Mill Crossen of SDAG Wismut - Final report**

INIS-mf-12190; 160 pp. (October 1990)

The uranium-ore processing plant at Crossen of the SDAG Wismut operated from 1950 until the end of 1989. Waste that was produced contains radioactive and chemical material and represents an additional exposure for man and the environment. The contamination of the Crossen site has been investigated as far as possible. Preliminary recommendations for reclamation are based on the evaluation of all available data. According to the proposed concept, all contaminated material resulting from reclamation will be deposited in an existing tailings pond and sealed for the protection of the surrounding environment. In the future, only one waste disposal site has to be monitored, while all other reclaimed areas can be used again for industrial purposes. Preliminary reclamation costs are estimated to be 770 million Deutschmarks. For technical reasons, the reclamation steps will take a period of approximately 10 years. The proposed remedial actions will substantially reduce the contamination of the environment in a reasonably short time. Further detailed investigations have to be conducted so that the final reclaimation program can be defined.

547

R. Hinz, Queensland Mines Limited, Darwin, Australia

**Revegetation and Tailings Disposal at Nabarlek**

CONF-8906333; Environmental Planning in Multiple Land Use Areas, Proceedings of the Eleventh North Australian Mine Rehabilitation Workshop, Jabiru, Australia, June 11, 1989, 206 pp.; (pp. 171-180) (1989)

The Nabarlek ore body was fully excavated and stockpiled prior to the processing, which enabled the open pit to be used as a depository for the tailings. After completion of ore processing and washing down of the plant work, Queensland Mines Limited commenced dewatering of the tailings to permit settlement to their final levels. An overview of the disturbed areas, as well as surface preparations and revegetation techniques for the Nabarlek project site is presented.

548

R.W. Holmes, D.B. Chambers, B.E. Halbert, M.L. Murray, and D.I. Beals, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada; Senes Consultants, Willowdale, Ontario, Canada

**Probabilistic Assessment of the Long-Term Effects of Uranium Tailings**

INIS-mf-12730; CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 522-529) (1986)

Predicting the long-term environmental effects of uranium mill tailings requires the use of mathematical models. Probabilistic analysis provides a framework for incorporating the inherent uncertainty in many of the model input parameters. The paper provides a brief overview of the concepts of probabilistic analysis and illustrates its application to uranium mill tailings. The paper describes the structure and features of the Canadian Uranium Tailings Assessment Program (UTAP), which was developed in a multiphase study for the National Uranium Tailings Program (NUTP). A brief review of the overall NUTP approach to model development is also provided.

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**Removal of Radium-226 from Uranium Mining Effluents and Leaching from Sludges**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

Effluents from uranium mining and milling operations are an important source of radium-226. In geographical areas having a net excess of precipitation over evaporation, an effluent is discharged from tailings areas to the surface water. This effluent may consist of either mine water or process water used to transport the tailings slurry from the mill to the tailings area. In many cases, this effluent contains unacceptably high levels of radium-226 and must be treated prior to discharge. This chapter examines treatment methods for the removal of radium-226 from such effluents. The information presented is based on the authors' own work and files, literature searching, and the results of a questionnaire on treatment practices sent to uranium producing companies and research institutions in most uranium producing countries. The chapter identifies the various known radium removal methods and discusses those having practical application. Conventional current technology, consisting of various modifications of the barium-radium sulphate [Ba(Ra)SO4] coprecipitation process, is discussed in great detail, with examples of full-scale use. The final section of the chapter considers the leachability of the sludge which is produced in Ba(Ra)SO4 coprecipitation processes. Of particular concern is the possibility for the leaching of radium-226 from this sludge once it is placed in a final disposal location.

550

International Atomic Energy Agency, Vienna, Austria

**The Environmental Behaviour of Radium - Volume 2**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

The objective of this publication is to provide an up-to-date review of the environmental behavior of radium, including methods for analysis, assessment and control. The need for a reference text on the subject was identified at an early stage of the International Atomic Energy Agency (IAEA) Co-ordinated Research Programme (CRP) on radium behavior in relation to uranium mining and milling wastes. This publication deals with (1) the sources, properties, and environmental behavior and (2) the methods of analysis, control, and assessment of radium-226. It is an outgrowth of IAEA programs directed towards the environmental problems involved in uranium mining and milling. The emphasis in several of the sections reflects these origins. For example, many of the contributions in Volume 2 of this report on technologically enhanced sources of radium (Part 1), methods of control and abatement (Part 2), and the impact on man (Part 3) are concerned with uranium mining and milling. Chapters of this report have been described in individual records with their own abstracts.

551

R.D. John, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada

**Research Into the Long-Term Environmental Effects of Uranium Tailings**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 266-272) (1986)

This paper features fundamental research for a mathematical model of the long-term environmental effect of uranium tailings. The model is being tested at Lacnor and at Rabbit Lake in Saskatchewan. Research has been done on acidification resulting from the bacterial oxidation of sulfide minerals such as pyrite. Primary radium is mobilized by this acidification process. Radium present in barium sulfate sludges can be mobilized by the action of sulfate-reducing bacteria. Other potentially toxic elements are less important; for instance, little thorium reaches the environment, and radon dissipates. A program of limnological studies has dealt with the fate of the relevant radionuclides in biota and sediments. Research has been done on liners and on ion exchange for radium removal.

552

S.R. Joshi, D.T. Waite, and R.F. Platford, Environmental Protection Service, Western and Northern Region, Edmonton, Alberta, Canada

**Vertical Distribution of Uranium Mill Tailing Contaminants in Langley Bay, Lake Athabasca, Alberta, Canada**

Science of the Total Environment 87-88:85-105 (1989)

From 1955-1964, radioactive mill tailings were produced during operation of the Gunnar uranium mine in Alberta, Canada. These tailings were originally discharged into a small nearby lake. Large quantities of these tailings subsequently moved into another small body of water and then into Langeley Bay, a shallow opening into Lake Athabasca. Analyses of several sediment cores reveal that the contamination, covering the entire bottom of the bay, reached Lake Athabasca. About 11% of the total Ra-226 activity discharged from the mill residues is found in Langeley Bay sediments, with about 76% still remaining at original disposal areas. Cesium measurements indicate that natural cover on the submerged tailings will develop at a very slow rate.

553

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**A Case Study of a Large Open Pit Uranium AML (Abandoned Mine Land) Project, Gas Hills, Wyoming**

CONF-900434; Mining and Reclamation - 1990, J. Skousen, J. Sencindiver, and D. Samuel (eds.), Proceedings of the American Society for Surface Mining and Reclamation Conference and Exhibition, Charleston, WV, April 23-26, 1990. West Virginia University Publication Services, Morgantown, WV, Vol. 2, 311 pp.; (pp. 513-519) (1990)

The Abandoned Mine Lands Program (AML), authorized under the Surface Mining Control and Reclamation Act of 1977, provides funding for the abatement of health and safety hazards on lands disturbed by mining prior to enactment of the act. A good example of the implementation of the AML Program in Wyoming is the A-8 Pit. The reclamation site is located in the East Gas Hills Uranium Mining District of Wyoming. Reclamation activities include (1) selective handling of 3.5 million cu yd of backfill, (2) controlling pit dewatering and water treatment, (3) installing second-order drainage channel and riprap control structures, and (4) salvaging sufficient coversoils and topsoils for site revegetation.

554

L. Lam, S.L. Barbour, and W.A. Meneley, Saskatchewan University, Saskatoon, Saskatchewan, Canada

**Seepage and Transport Modelling for a Uranium Tailings Dam in Northern Saskatchewan**

INIS-mf-12730; CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 530-537) (1986)

Disposal facilities for uranium tailings are commonly designed as surface or shallow subsurface facilities. Designing such facilities requires an understanding of contaminant transport processes under both saturated and unsaturated flow conditions. This paper presents a saturated-unsaturated finite element model to simulate the movement and distribution of contaminants in groundwater flow systems. The finite element solution of the governing equations is based on the Galerkin weighted-residual method. The nonlinearity of the seepage equation in the unsaturated zone is solved by iterative techniques. The physical properties of several materials relevant to saturated-unsaturated flow modelling are presented. The modelling results of a representative section through the tailings dam of the Cluff Lake Mine tailings impoundment are presented as an example of how modelling techniques may be applied to design.

555

E.R. Landa, U.S. Geological Survey, Water Resources Division, Reston, VA

**Leaching of Radium-226 from Components of Uranium Mill Tailings**

Hydrometallurgy 26:361-368 (1990)

A sequential extraction procedure was used to characterize the geochemical forms of radium-226 retained by mixtures of quartz sand and a variety of fine-grained rock and mineral species. These mixtures had previously been exposed to the sulfuric acid milling liquor of a simulated acid-leach uranium milling circuit. For most test cases, the major fraction of the radium-226 was extracted with 1 mol/NH4Cl and was deemed to be exchangeable. However, radium-226 retained by the barrite-containing mixture was resistant to both 1 mol/NH4Cl and 1 mol/1HCl extraction.

556

E.R. Landa and C.A. Bush, U.S. Geological Survey, Water Resources Division, Reston, VA; U.S. Geological Survey, Denver, CO

**Sorption of Radionuclides by Components of Uranium Mill Tailings**

Proceedings of the First International

Conference on Hydrometallurgy, Beijing, China, October 12-15, 1988; (pp.661-665) (1988)

The solubilization and subsequent resorption of radionuclides by ore components or by reaction products during the milling of uranium ores may have both economic and environmental consequences. Particle-size redistribution of radium during milling has been demonstrated by previous investigators; however, the identification of sorbing components in the tailings has received little experimental attention. Uranium-bearing sandstone was milled on a laboratory scale with sulfuric acid. At regular intervals, filtrate from this suspension was placed in contact with mixtures of quartz sand and various potential sorbents which occur as gangue in uranium ores; the potential sorbents included clay minerals, iron and aluminum oxides, feldspar, fluorspar, barite, jarosite, coal, and volcanic glass. The quartz sand-sorbent mixtures were radioassayed by gamma-spectrometry to determine the radon emanation coefficients and concentrations of U-238, Th-230, Ra-226, and Pb-210. Sorption of U-238 was low in all cases, with maximal sorptions of 1-2% by bentonite- and coal-bearing samples. Th-230 sorption also was generally less than 1%; maximal sorption here was observed in the fluorspar-bearing sample and appears to be associated with the formation of gypsum during milling. Ra-226 and Pb-210 generally showed higher sorption than the other nuclides. More than 60% of the Ra-226 solubilized from the ore was sorbed on the barite-bearing sample. The mechanism(s) for this sorption by a wide variety of substrates is not yet understood. Radon emanation coefficients of the samples ranged from about 5-30%, with the coal-bearing samples clearly demonstrating an emanating power higher than any of the other materials.

557

H.F. Lucas, Argonne National Laboratory, Argonne, IL

**Radium-226 Whole-Body Gamma Counting and Radon-222 Breath Analysis: Report on a Subject Exposed to Uranium Mill Tailings**

Health Physics 60(2):163-167 (February 1991)

One of two boys born in September 1949 who played on uranium mill tailings between ages 8 and 12 was diagnosed as having leukemia at age 15 years, 6 months. The exposed and control subjects were well matched: they were approximately the same age, and both were 1.85 m (6 ft 1 in.) in height and weighed 75.2 kg (165 lb). The result obtained by the gamma spectrometric method for the exposed subject was 0 + or - 17 Bq (0 + or - 470 pCi), while that for the control subject was 4 + or - 15 Bq (100 + or - 400 pCi). The result obtained by the Rn breath method for the exposed subject was 4.4 + or - 0.7 Bq (120 + or - 20 pCi), while that for the control was 5.4 + or - 1.4 Bq (150 + or - 38 pCi). These results suggest that the Ra-226 body burden of the exposed subject is within the range of body burdens observed in subjects exposed only through normal food sources. These subjects have a mean Ra-226 content of 1.5 Bq (range: 0.4-4.4 Bq) indicating no significant mill-tailing intake. The best estimate of alpha particle dose from Ra-226 and its decay products to the red marrow of the exposed subject was 0.05 mGy at age 14 and 0.10 mGy at age 38. This dose, when compared to that observed in the dial painters, suggests that the leukemia was not caused by uptake of radium from the mill tailings.

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R.J. Lyon, F.H.F. Au, and J.M. Hans, U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV

**Radon Concentrations Around the L-Bar Uranium Mill Site**

EPA/520/6-88/059; 29 pp. (October 1988)

The report gives the results of measurements of radon concentrations which were made in the vicinity of the uranium mill tailings pile of SOHIO L-Bar site near Seboyeta, New Mexico, using passive environmental radon monitors. Radon concentrations were determined monthly and the results of the data showed that radon concentrations decreased with distance from the center of the tailings pile.

559

M.M. MacDonell, Northwestern University, Evanston, IL

**Uptake of Radium-226 from Uranium Mill Tailings by C-3 and C-4 Plants and Implications for Transport of Radium-226 and Radon-222 into the Disposal Site Environment**

Dissertation Abstracts International 47(06-B):2544-2666 (1986)

Radium-226 entry into plants grown on uranium mill tailings at pH 6.5 appears to be governed primarily by movement of tailings solution into the plant. The lower transpiration ratios of C-4 photosynthetic plants as compared to C-3 plants result in lower tissue concentrations of radium-226. In each case, the distribution of radium-226 within the plants studied - corn (C-4), dwarf sunflower (C-3), tall fescue grass (C-3), and four species of Panicum (two C-3 and two C-4) - exhibited an acropetal gradient, decreasing from the roots where the concentrations are relatively high to the apex of the plant. Tissue concentrations of Ra-226 decreased over time, attributable to increases in biomass while total Ra-226 levels remain constant. Release of radon from vegetated tailings was found to be directly related to the total leaf area of the plant following introduction into the plant of tailings solution. Thus, the plant pathway is shown to be an important mechanism for the transport of radium-226 and radon-222 from mill tailings into the environment. Current tailings-disposal-site reclamation efforts should consider the effects of the photosynthetic nature of the vegetation species and its total leaf area to reduce the potential for introduction of these elements into the site environment.

**560**

MacLaren Plansearch, Inc., Ottawa, Ontario, Canada

**Optimization in the Decommissioning of Uranium Tailings: A Report**

MIC-90-04406; INFO-0321350 (1987)

A detailed examination of the problem of choosing the optimal decommissioning approach for uranium and mill tailing sites. Various decision methods are discussed and evaluated, and their application in similar decision problems are summarized. The report includes, by means of a demonstration, a step-by-step guide to how cost-benefit, cost-effectiveness, and multiattribute utility theory and decision system techniques can be applied to a decommissioning problem. The strengths and weaknesses of the various methods are highlighted.

**561**

G. Markos and K.J. Bush, Geochemistry and Environmental Chemistry Research, Inc., Rapid City, SD

**Investigation of Contamination of Earthen Covers on Inactive Uranium Mill Tailings**

DOE/UMT-0250; 114 pp. (1983)

The upward migration of contaminants into earthen covers on uranium mill tailings was evaluated from chemical and isotopic analysis of samples from 5-10 cm intervals through the cover and into the tailings at three locations on the Riverton pile. The Uranium Mill Tailings Remedial Action Project elected to determine the significance of migration of salts and contaminants into earthen covers emplaced on tailings by funding this investigation of the migration which has occurred through an earthen cover since the time of emplacement on an inactive uranium mill tailings pile. The Riverton tailings pile, covered with 20 to 40 cm of local sandy soil, was chosen for the study. The objectives of the study were to (1) determine vertical distributions of concentrations of salts, trace metals, and radionuclides through the cover and into the tailings; (2) determine the concentrations of salts and contaminants in the cover from chemical migration; (3) relate the migration of salts to the contaminants; (4) model the mechanisms responsible for promoting and retarding migration; and (5) evaluate the chemical and physical properties of the cover influencing migration.

**562**

**Mary Kathleen Benchmark Earns Rehabilitation Award**

Queensland Government Mining Journal 89(1041):315-318 (August 1988)

The rehabilitation concept of the Mary Kathleen mine site is described. The aim was to make the mine and the town site safe for public access from the point of view of radiation and physical hazards, as well as to encourage natural revegetation on erosion-resistant surfaces. The development of a computer model of the various groundwater and surface water migration systems enabled long trends to be predicted and verified with a minimum of post-rehabilitation monitoring.

**563**

M.A.J. Matich, W.F. Tao, and A.R. Morrish, Geocon, Inc., Mississauga, Ontario, Canada; Eldorado Resources Limited, Saskatoon, Saskatchewan, Canada

**The Rabbit Lake Open Pit Tailing Disposal System**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 45-54) (1986)

The Rabbit Lake open pit tailings depository is a belowground tailings disposal system that takes advantage of existing low groundwater hydraulic gradients and low tailings permeabilities to preventing the outmigration of contaminants. Establishing a highly permeable surrounding around the tailings, connected to a pumped underdrainage system, ensures maximum consolidation of tailings during placement. When pumping ceases at abandonment it provides a preferential path for groundwater flow around the fully consolidated tailings.

**564**

R.H. McCorkell and M. Silver, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada

**Effect of Compost and Soil Covers on Radon Emanation from Uranium Tailings**

CIM Bulletin 80(908):43-45 (December 1987)

The effects of covering materials on radon emanations from uranium mill tailings were investigated. Granular materials with air in the spaces allow radon to pass freely. Moist covers of compost or soil decrease radon emanation from tailings. Water-saturated covers were more effective, and freezing the tailings with these covers further decreased radon escape. Water itself is a poor radon barrier, probably because of circulation. Plants had no effect on radon emanation through soil. Although radon diffusion through water-saturated powders appears to be very slow and inefficient, about 25% of the radon escaping from the grains in water-saturated tailings diffuse to the surface and emanate when no cover is present. The radon escaping from tailings through covers of water-saturated compost or soil is no more than could be accounted for by radon produced in the covers themselves.

**565**

T. Meadley, S.L. Barbour, and W.A. Meneley, Amok Limited, Saskatoon, Saskatchewan, Canada; Saskatchewan University, Saskatoon, Saskatchewan, Canada; W.A. Meneley Consultants Limited, Saskatoon, Saskatchewan, Canada

**A Conceptual Decommissioning Plan for a High Grade Uranium Mine**

INIS-mf-12807; CONF-880943; Uranium and Electricity: The Complete Nuclear Fuel Cycle, K.H. Talbot and V.I. Lakshmanan (eds.), Proceedings of an International Symposium, Saskatoon, Canada, September 18-21, 1988, 411 pp.; (pp. 7.32-7.35) (1988)

At the completion of the milling operations at Cluff Lake, the tailings management area will contain mill tailings that have typical Ra-226 concentrations of 17 Bq/g and in some areas concentrations as high as 274 Bq/g. A conceptual decommissioning plan has been developed for this area that will maintain radium concentrations in the adjacent lake to levels that are less than the surface water quality objectives set by the provincial government. A computer model based on field observations and laboratory experiments has been used to demonstrate the viability of the plan.

566
L.A. Melis and J.W. Rowson, Melis Engineering/Cluff Mining, Lake Athabasca, Saskatchewan, Canada

**Operation of a Gold Extraction Circuit for Recovery of Gold from Uranium Mill Tailings at Cluff Lake, Saskatchewan**

Canadian Institute of Mining and Metallurgy Bulletin 82(931):42-46 (November 1989)

Cluff Mining has successfully operated a gold recovery plant at its Cluff Lake operation in northern Saskatchewan to recover gold from Phase I uranium leach tailings. The operating circuit consists of tailings, repulping, grinding, cyanidation, carbon-in-pulp, gold recovery, and cyanide destruction by acidification, volatilization and reneutralization. The process is described and operating data and metallurgical results from the operation are provided.

567
H. Michaelis, Randol International Limited, Golden, CO

**Integrated Biological Systems for Effluent Treatment from Mine and Mill Tailings**

Environmental Management of Solid Waste - Dredged Material and Mine Tailings, Proceedings of a Conference, Springer-Verlag, Berlin, Federal Republic of Germany; (pp. 99-113) (1988)

The topics reviewed include (1) effluent treatment needs in mining and mineral processing; (2) an integrated biological process concept which includes aquatic plant/algal/bacterial treatment of waste water streams; and (3) the applicability of integrated biosystems. Examples of biological treatment of effluents given include (a) metals polished by a natural marsh; (b) artificial meander systems; (c) passive mine drainage treatment in Colorado; (d) sphagnum moss oxidation of ferrous ion; (e) removal of organics and metals in Missouri; (f) wood chips and agriwaste (as a carbon source and substrate) in acid-mine-drainage treatment; (g) cyanide degradation in effluents; and (h) removal of selenium and uranium by algae.

568
P. Michel, Societe Industrielle des Minerais de l'Ouest, Velizy-Villacoublay, France

**Treatment and Valorization of Discarded Materials from the Uranium Ore Dressing Mills of SIMO**

Report; 71 pp. (June 1989)

Environmental constraints have induced many mine operators (in particular Simo) to employ careful processing techniques and to upgrade the tailings produced in their ore dressing plants. Descriptions of these techniques are given.

569
C.L. Miller, E.R. Landa, and D.M. Updegraff, U.S. Geological Survey, Water Resources Division, Arvada, CO; U.S. Geological Survey, Water Resources Division, Reston, VA; Colorado School of Mines, Golden, CO

**Ecological Aspects of Microorganisms Inhabiting Uranium Mill Tailings**

Microbial Ecology 14:141-155 (1987)

Numbers and types of microorganisms in uranium mill tailings were determined using culturing techniques. Arthrobacter were found to be the predominant microorganism inhabiting the sandy tailings, whereas Bacillus and fungi predominated in the slime tailings. Sulfate-reducing bacteria, capable of leaching radium, were isolated in low numbers from tailings samples, but were isolated in significantly high numbers from topsoil in contact with the tailings. The results are placed in the context of the magnitude of uranium mill tailings in the United States, the hazards posed by the tailings, and how such hazards could be enhanced or diminished by microbial activities. Patterns in the composition of the microbial population are evaluated with respect to the ecological variables that influence microbial growth.

570
L.L. Miller, C.L. Strachan, and H.P. Estey, Water, Waste and Land, Inc., Fort Collins, CO; Exxon Company, New Orleans, LA

**Reclamation of Exxon Ray Point Tailings Basin**

Journal of Energy Engineering 115(3):120-131 (December 1989)

This paper outlines key items for reclamation of uranium tailing impoundments, using the reclamation of the Exxon Coal and Minerals Company (ECMC) Ray Point (or Felder) uranium mill site and tailings impoundment as a case history. The ECMC Ray Point is the first Title II site for which a final reclamation plan has been approved and constructed. Initial reclamation work of the Ray Point site consists of mill decommissioning, mill site cleanup, and initial tailings impoundment cover placement. The licensing process in Texas consists of submitting the reclamation plan documents to the Texas Department of Health, with subsequent discussion of the plans and submittal of additional data, analyses, and clarification. Following approval of the Ray Point reclamation plan, final reclamation work is carried out; it consists of random fill placement, compacted soil cover construction, topsoiling, and revegetation.

571
M.L. Murray, D.B. Chambers, R.A. Knapp, and R.W. Holmes, Senes Consultants, Willowdale, Ontario, Canada; Department of Energy, Mines and Resources, Ottawa, Ontario, Canada

**An Approach to Risk Assessment for Canadian Uranium Mill Tailings**

CONF-8609486; Radioactive Waste Management, Proceedings of the Second International Conference, Winnipeg, Ontario, Canada, September 7-11, 1986, 821 pp.; (pp. 273-280) (1986)

Quantitative risk analysis provides a framework for considering the consequences of sequences of events (scenarios) in proportion to their likelihoods of occurrence. This paper considers risk as a "set of triplets" consisting of scenarios, the likelihoods of those scenarios occurring, and their consequences should they occur. Both the likelihood of an event (or scenario) occurring and its consequence may be uncertain quantities. The risk quantification method presented allows incorporation of these uncertainties. This paper discusses the concept of risk and demonstrates how the consequences of a number of scenarios involving naturally occurring events can be combined to estimate the overall risk arising from uranium mill tailings.

572
National Technical Information Service, Springfield, VA

**Uranium Mining and Milling Environmental Studies - February 1984 to May 1987: A Bibliography from the NTIS Data Base**

PB-90-868951; 183 pp. (May 1990)

This bibliography contains citations concerning environmental and social aspects of uranium mining, milling, and ore treatment. Environmental and social aspects include air and water pollution, public health, occupational safety, land reclamation, and waste disposal. The citations refer to monitoring and control of contaminants, and environmental surveys and impact statements for specific areas in the vicinity of mining and ore treatment facilities. There are also references to health studies performed on miners and millworkers. (This updated bibliography contains 349 citations, none of which are new entries to the previous edition.)

573
National Technical Information Service, Springfield, VA

**Uranium Mining and Milling Environmental Studies - June 1987 to May 1990: A Bibliography from the NTIS Data Base**

PB-90-868969; 105 pp. (May 1990)

This bibliography contains citations concerning environmental and social aspects of uranium mining, milling, and ore treatment. Environmental and social aspects include air and water pollution, public health, occupational safety, land reclamation, and waste disposal. The citations refer to monitoring and control of contaminants and environmental surveys and impact statements for specific areas in the vicinity of mining and ore treatment facilities. There are also references to health studies performed on miners and millworkers. (This updated bibliography contains 176 citations, all of which are new entries to the previous edition.)

574
National Technical Information Service, Springfield, VA

**Uranium Ore Treatment - January 1970 to May 1981: A Bibliography from the COMPENDEX Data Base**

PB-90-869777; 267 pp. (May 1990)

The treatment of uranium ores is reviewed with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 300 citations, none of which are new entries to the previous edition.)

575
National Technical Information Service, Springfield, VA

**Uranium Ore Treatment - June 1981 to March 1990: A Bibliography from the COMPENDEX Data Base**

PB-90-869785; 110 pp. (May 1990)

The treatment of uranium ores is reviewed, with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 265 citations, all of which are new entries to the previous edition.)

576
L. Nilsson and E. Forssberg, Luleaa University, Luleaa, Sweden

**Solubility of Radionuclide Species from Uranium Mill Tailings**

Mineral Engineering 1(4):295-310 (1988)

Solubility of different radionuclides, especially Ra-226, from uranium mill tailings is described. The solubility in water has been studied in both column and shake flask leaching tests. The test material used came from a uranium deposit at Lilljuthatten, in the Swedish province of Jamtland. The results of the study show that neutralization sludge and/or fine particles have an adsorbing capacity on Ra-226. Furthermore, by adding barium sulphate to the tailings pile, a substantial decrease of Ra-226 in the water could be observed.

577
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney, Australia

**Alligator Rivers Region Annual Report - 1988-1989**

Report; 192 pp. (1989)

Information on administration, environmental protection arrangements, and supervisory and research activities of the Office of the Supervising Scientist is presented for the period July 1, 1988, to June 30, 1989. Main developments include (1) further options concerning waste management at the Ranger uranium mine and (2) the differences between the Northern Territory Government and the Commonwealth Government on a series of environmental issues in relation to the mining operations in the Alligator Rivers Region.

578
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney, Australia

**Alligator Rivers Region Annual Report - 1989-1990**

Report; 202 pp. (1990)

The report outlines the Office of the Supervising Scientist (OSS) activities in meeting its responsibilities in the protection of the environment from the effects of uranium mining operations in the Alligator Rivers Region of the Northern Territory. Significant developments include (1) review of the role, operations, and research program of the OSS; (2) construction of the stage IV raise of the Ranger tailings dam; (3) establishment of new zone boundaries for the Conservation Zone; and (4) release of the final environmental impact statement for the proposed Corronation Hill mine. Appendixes on legislation, agreements, authorizations and approvals, environmental infringements and incidents, publications, reports, and conference presentations are included.

579

K. Pilegaard, Risoe National Laboratory, Roskilde, Denmark

**Preliminary Environmental Impact Statement for the Kvanefjeld Uranium Mine**

RISO-M-2875; 130 pp. (September 1990)

The sources of pollution from a proposed uranium mining and milling complex at Kvanefjeld in South Greenland have been evaluated. The environmental impact assessment was part of a prefeasibility study. The main aims of this study have been to identify potential pollutants and critical pathways, to evaluate the environmental impact of technical alternatives, and to provide guidelines for preoperational environmental studies. The study has identified the open pit, waste dump, and tailings impoundment as the most important sources of pollution. The mobility of nonradioactive elements was lower in the tailings than in the ore, whereas the reverse was true for the radioactive elements. The potential pollutants include beryllium, fluorine, vanadium, chromium, manganese, iron, cobalt, nickel, zinc, arsenic, selenium, rubidium, niobium, zirconium, molybdenum, cadmium, antimony, mercury, lead, thorium, uranium, REE, Ra-226, Pb-210, and Po-210. This list was based on abundance and mobility in the ore and tailings and on general toxicity of the elements. Fluorine is the most mobile of the elements in both ore and tailings. Because the concentration of flourine in ore and tailings may be up to 1% and because it is highly toxic, fluorine is the most serious pollutant.

580

G.M. Ritcey, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada; International Atomic Energy Agency, Vienna, Austria

**Control and Abatement of Effluents from Uranium Mining and Milling**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

During the life of a uranium mine/mill complex, tailings and waste rock are continually being generated and deposited onto the tailings area. Contaminants (both radioactive and nonradioactive) present in the wastes may pose a risk to the public and the environment. It is, therefore, desirable for controls to be exercised as to the methods used for disposal to prevent or minimize contaminant dispersal. The tailings disposal site must be chosen with care, with concern for proper dam design and construction, incorporating appropriate liners. Tailings deposition methods should be chosen to be compatible with the particular ore, process, climatic conditions, and effluent treatment technologies being used consistent with minimizing environmental contamination. The control and modification of processes within the mill itself may also be necessary to achieve environmental control objectives.

581

G.M. Ritcey, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada; International Atomic Energy Agency, Vienna, Austria

**Weathering Processes in Uranium Tailings and the Migration of Contaminants**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

The degree to which weathering affects mill tailings and the subsequent release and mobilization of contaminants depends on a number of important factors: (1) characterization of the tailings - the mineralogy and associated gangue minerals, the leach process, particle size, type and nature of the sulphide minerals, tailings treatment (i.e., dewatering and neutralization), the chemical nature of slurry water (pH, Eh, ions); (2) oxidation reactions involved in the conversion of sulfides to sulfuric acid, whether by chemical or bacterial oxidation; (3) the role of bacteria present, whether iron oxidizing or sulphate reducing, and the relative population of the microorganisms; (4) stability of Ba(Ra)SO4 precipitation in the tailings with respect to the effect of weathering and bacteria, particularly that of the sulphate reducing microorganisms; (5) the influences of hydrology and geology relating to the siting of the tailings, dam construction, method of tailings deposition, amount of groundwater in and out of the tailings, amount of process water remaining with the solids which affect the quantity and quality of the seepage, rainfall, atmospheric temperature, seasonal flooding, dissolved O-2 or other gases, porosity and permeability, geochemical processes of sorption, desorption, precipitation, and redissolution, capillary forces, electrolyte concentrations and salt formation; (6) migration of salts upward by capillary action. Static leach tests on tailings can provide valuable information as to some of the chemistry occurring within the tailings impoundments. However, more valid information can be gained by long-term controlled, weathering tests in lysimeters where a number of parameters can be monitored and assessed simultaneously.

582

G.M. Ritcey, Canada Centre for Mineral and Energy Technology, Ottawa, Ontario, Canada; International Atomic Energy Agency, Vienna, Austria

**Decommissioning and Reclamation of Mines by the Use of Covers**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

After a mine/mill has ceased operation, the plant goes into the abandonment phase. Unfortunately, the environmental problems that existed during the operation of the plant often extend into the postoperation phase. Because maintenance of tailings is expensive during operation, it does not make economic sense to extend this expensive care into perpetuity. Because of that concern there has to be considerable research for each type of mining operation so that sound decommissioning procedures for abandonment, which will minimize the long-term maintenance costs of tailings is devised. To attain these objectives, the current pollution control techniques are reviewed and the best practical technology to ensure there is no problem is recommended. Once a mine has closed out, it is not necessarily a "walk away" situation because (1) access to the site is not restricted, (2) removal of potentially dangerous material from the site is possible, and (3) monitoring will be required in the future. The selection of the cover method will be dependent upon the ultimate close-out objectives, the costs that can be assumed at the time, and costs of long-term maintenance of the cover. The selection will therefore be dictated by climatic conditions, topography, mineralogy and chemical composition of the tailings, the tailings disposal method used, the availability and cost of cover materials, and the time and cost of long-term maintenance. The design and selection of the cover will suppress dust and water erosion, decrease or suppress radon diffusion, provide an aesthetic appearance, and restore the land to productive use. The ultimate cover would be a self-regenerating one provided by nature which would fulfil the objectives of lowest cost, lowest maintenance, dust suppression, and effluent quality capable of satisfying environmental constraints.

583

H.D. Sauer

**Uranium Mining in Eastern Germany: a First Stocktaking**

Energiewirtschaftliche Tagesfragen 40(12):886-888 (December 1990)

Western Germany has not experienced the problems related to uranium mining as has Eastern Germany (SDAG Wismuth). The cleanup and control measures which are urgently needed in Eastern Germany will be a task for more than one generation.

584
W.J. Snodgrass, Beak Consultants Limited, Mississauga, Ontario, Canada; International Atomic Energy Agency, Vienna, Austria

**The Chemistry of Radium-226 in the Uranium Milling Process**

IAEA Technical Reports Series No. 310; 446 pp. (1990)

Uranium mining, ore crushing, grinding, and leaching can substantially redistribute radium in the environment. Solvent extraction or other separation processes leave mill tailings with high Ra-226 concentration. Radium is readily adsorbed on the surfaces of leached solids or coprecipitated with barium sulfates. More solid ore phase studies are required to identify all the physicochemical mechanisms controlling Ra-226 dissolution from leaching ore-liquor systems.

585
W.J. Snodgrass and J. Molineri, Beak Consultants Limited, Toronto, Ontario, Canada; Commissariat a l'Energie Atomique, Centre de Marcoule, Bagnols-sur-Ceze, France

**Low Activity Uranium Waste Management**

INIS-mf-12807; CONF-880943; Uranium and Electricity: The Complete Nuclear Fuel Cycle, K.H. Talbot and V.I. Lakshmanan (eds.), Proceedings of an International Symposium, Saskatoon, Canada, September 18-21, 1988, 411 pp.; (pp. 7.9-7.16) (1988)

A global perspective on the management of low activity uranium mill wastes is developed in this paper. The perspective is developed by examining the geochemical forms of radionuclides and heavy metals in the tailings. Then the probable effects of different management factors such as site selection, tailings site design (above grade, below grade, etc.), milling process selection, geomorphological setting, geotechnical factors, waste treatment, infiltration rates, and temperature are related to these geochemical forms and the potential for radiological/toxicological risk to humans. Finally, alternative management philosophies (containment or dispersal) and their impact on management are examined. At the conference, the geochemical perspective is calibrated by presentation of a few site-specific examples from around the world.

586
C.F. Tsang, Lawrence Berkeley Laboratory, Berkeley, CA

**Development of an Algorithm for the Biogeochemical Evolution of Uranium Mill Tailings**

Book; 795 pp. (1987)

This paper presents an analysis of relevant time scales for modeling the geochemical evolution of uranium mill tailings (seconds to millions of years). It is suggested that the chemical retention time of pore water is an appropriate parameter for assessing the interaction of transport and kinetics in formulating an algorithm for the evolution of uranium mill tailings.

587
U.S. Department of Energy, Office of Energy Research, Washington, DC

**Groundwater Cleanup: Biosorption**

DOE/ER-0484P; Technology '90: Accomplishments in Technology Transfer from DOE and Its Laboratories, 192 pp.; (p. 77) (January 1991)

There are frequently a number of contaminants, including uranium, vanadium, strontium, and cadmium, in the groundwater and soil under mining sites. These metals are frequently present at toxic levels and are possibly carcinogenic. The hazardous metals that contaminate the groundwater come from mine tailings, waste rock, and chemicals left from mining and milling operations. Mine tailings are now stored in clay-lined beds; however, in the past, tailings were usually dumped into pits near the mine. Rainwater trickling down through the tailings in the pits carried the metals to the subsoil and eventually to the groundwater. A team of biotechnologists at the Idaho National Engineering Laboratory (INEL) are working on ways to use microorganisms to clean up groundwater contaminated by wastes from old uranium mines. INEL researchers know that microorganisms are found naturally in wastes from uranium mines, and that the microorganisms affect the rate at which uranium and other metals are dissolved into water.

588

C. Unger, A. Armstrong, C. McQuade, G. Sinclair, J. Bywater, and G. Koperski, Ranger Uranium Mines Limited, Jabiru, Australia; Northern Territory Department of Mines and Energy, Darwin, Australia

**Planning for Rehabilitation of the Tailings Dam at Ranger Uranium Mines**

CONF-8906333; Environmental Planning in Multiple Land Use Areas, Proceedings of the Eleventh North Australian Mine Rehabilitation Workshop, Jabiru, Australia, June 11, 1989, 206 pp.; (pp. 153-165) (1989)

Tailings management options and planning currently under way for the rehabilitation of the tailings dam at Ranger are described. A table summarizes the research projects in progress and how they are directed towards long-term rehabilitation of the tailings.

589

D.M. Updegraff, C.L. Miller, and E.R. Landa, U.S. Geological Survey, Denver, CO; U.S. Geological Survey, Water Resources Division, Reston, VA

**Characterization of Arthrobacter Isolated from Uranium Mill Tailings**

USGS-OFR-86-527; 8 pp. (1986)

Earlier work by the present authors indicated that radium-226 is leached from uranium mill tailings by sulfate-reducing bacteria. Studies of the microorganisms present in such tailings showed that sulfate-reducing bacteria, Bacillus species and Arthrobacter species, could be isolated from the tailings. Arthrobacter was by far the predominant microbial genus in the sand fraction of the mill tailings; Bacillus and fungi predominated in the very fine slime fraction. This report discusses the methods of characterizing 10 bacterial isolates thought to be Arthrobacter. Ten bacterial cultures were isolated: seven from uranium-mill tailings; one from soil, and two from uraniferous peat; all cultures were classified by usual microbiological methods. Nine of the ten cultures were classified as Arthrobacter species on the basis of morphology, biochemical characteristics, and nutritional requirements. These cultures grew well on nutrient agar and EYGA agar, and exhibited the rod-to-coccus transformation characteristic of Arthrobacter species. The other culture, originally isolated from peat, was identified as Pseudomonas putida. All 10 cultures were obligate aerobes, and all were prototrophic, requiring no vitamins or accessory growth factors.

590

E. Veska and R.S. Eaton, Health and Welfare Canada, Ottawa, Ontario, Canada

**Abandoned Rayrock Uranium Mill Tailings in the Northwest Territories: Environmental Conditions and Radiological Impact**

Health Physics 60(3):399-409 (March 1991)

Field and laboratory investigations of the environment surrounding abandoned uranium mill tailings at Rayrock, Northwest Territories, Canada, were undertaken to examine the extent of Ra-226 and uranium contamination. Samples of groundwater, surface water, and unconsolidated geological material from the Rayrock area were collected for chemical and radiochemical analyses. Results indicated that the surface waters contained levels of Ra-226 as high as 20 Bq X 10(E-1), Pb-210 as high as 1.1 Bq X 10(E-1), and groundwater uranium as high as 2800 micrograms X 10(E-1). Lower levels of Ra-226, Pb-210, and U - 3.6 Bq X 10(E-1), 0.5 Bq X 10(E-1), and 4 micrograms X 10(E-1), respectively - were found in a small lake adjacent to the tailings area. Analysis of tailings and soil in the immediate vicinity indicates that the radionuclides and uranium are mobilized and can move within the tailings. Some of the mobilized radionuclides will be bound by the surrounding peat. The remainder may move to Lake Alpha in groundwater. Surface water flow also transports some contaminants into the water of Alpha Creek and Lake Alpha. The potential annual external and internal dose equivalents to a hypothetical resident were calculated based on exposure from the abandoned uranium mill tailings, drinking water, and fish caught in the lakes in the vicinity of the tailings. While Alpha Creek and Lake Alpha water showed evidence of contamination, the rest of the water system and the fish were at natural background levels of radioactivity.

591

W.J. Waugh, M.E. Thiede, and L.L. Cadwell, Chem-Nuclear Geotech, Inc., Albuquerque, NM

**Vegetation, Gravel Admixtures, and Soil Water Interactions in Engineered Covers**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 281-290) (April 1990)

Vegetative covers have been proposed for top-slopes of uranium mill tailings and low-level waste disposal cells. The attributes of vegetative covers include control of water infiltration into underlying waste, resistance to plant and animal intrusion, and erosion protection. However, at arid and semiarid sites, the attainable vegetation may not adequately stabilize the surface, particularly when it has been disturbed by drought, fire, or grazing. At these sites, rock mulches may be required, interacting with vegetation to control soil loss The purpose of this research was to measure the influences of rock mulches and admixtures on soil water balance and plant growth.

592

M. Wedd, Northern Territory Department of Mines and Energy, Darwin, Australia

**The Regulation of Uranium Mining in the Northern Territory**

CONF-8906333; Environmental Planning in Multiple Land Use Areas, Proceedings of the Eleventh North Australian Mine Rehabilitation Workshop, Jabiru, Australia, June 11, 1989, 206 pp.; (pp.13-18) (1989)

The regulatory framework developed for uranium mining operations in the Northern Territory is reviewed. The respective roles of commonwealth government, state government and other regulatory authority are described. Although complex, expensive, and cumbersome, the regulatory process has so far ensured input from diverse interest groups and allowed for environmental protection control in the Alligator River Region.

593

D.A. York and P.L. Aamodt, Los Alamos National Laboratory, Los Alamos, NM

**Remediation of Contaminated Soil Using Heap Leach Mining Technology**

Mining & Mineral Processing Wastes, Proceedings of the Western Regional Symposium, Berkeley, CA, May 30-June 1, 1990. Society for Mining, Metallurgy & Exploration, Inc., Littleton, CO; (pp. 244-259); LA-UR-90-701; CONF-9005.3; Mining and Mineral Processing Wastes, Proceedings of the Western Regional Symposium, Berkeley, CA, May 30-June 1, 1990; (6 pp.) (1990)

The U.S. Department of Energy (DOE) has come under criticism recently for its past methods of disposal of waste products from nuclear materials processing. The societal and regulatory pressure to clean up old waste sites, minimize waste generation, and conduct operations in an environmentally safe manner has resulted in a major refocusing of many DOE priorities. The highest emphasis is being placed on health, safety, and environmental issues. Los Alamos National Laboratory is evaluating the technology for heap treatment of excavated soils (from government and industrial waste sites) to remove and treat hazardous chemical and radioactive wastes. This new technology would be an extrapolation of current heap-leach mining technology. Some recovery rates for heap leaching of precious metals now exceed 95%, with metal-to-ore recovery ratios of less than one part per million. This implies that a similar technology might be developed to

excavate and process large quantities of contaminated soils to recover small but hazardous amounts of waste. The candidate wastes for treatment are those organic or inorganic (including radioactive) compounds that will chemically, physically, or biologically react with selected reagents. The project would start with bench-scale testing, followed by pilot-scale and field-scale testing. Various reagents would be tried in various combinations and sequences to obtain and optimize the desired treatment results. The field-scale testing would be preceded by site characterization, process design, and equipment selection. The final step in this project is to transfer the systems technology to the private sector, probably to the mining industry.

# TECHNICAL MEASUREMENTS CENTER

594

M.D. Pearson, UNC Geotech, Inc., Technical Measurements Center, Grand Junction, CO

**Radon-Daughter Grab-Sampling Technical Exchange Meeting - April 10-14, 1989**

DOE/ID/12584-44; 41 pp. (August 1989)

The U.S. Department of Energy (DOE) Office of Remedial Action and Waste Technology established the Technical Measurements Center to provide standardization, calibration, comparability, verification of data, quality assurance, and cost-effectiveness for the measurement requirements of DOE remedial action programs. These programs include the Uranium Mill Tailings Remedial Action Program, the Surplus Facilities Management Program (SFMP), the Formerly Utilized Sites Remedial Action Program, and the Grand Junction Remedial Action Program. The Technical Measurements Center is located in Colorado at the DOE Grand Junction Projects Office. One of the remedial action measurement needs is the estimation of average indoor radon-daughter concentration. The Technical Measurements Center sponsored a technical exchange meeting April 10-14, 1989, for the purpose of providing an opportunity for comparison of radon-daughter, grab-sample measurements by remedial action contractors. The Radon/Radon-Daughter Environmental Chamber at the DOE Grand Junction Projects Office was used for the meeting. The meeting findings indicate that comparable results for radon-daughter, grab-sample measurements can be obtained by technicians using a variety of instruments. Technicians should be particularly aware of problems with inaccurate air volume measurements and mistakes in data reduction programs as sources of error.

# ENVIRONMENTAL RESTORATION PROGRAM

595

**A Bill to Authorize Private Sector Participation in Designing, Constructing, Owning, and Operating Facilities which Support Department of Energy Waste Cleanup and Modernization Missions**

U.S. House Resolution HR-5880, Introduced in the House of Representatives, One Hundredth First Congress, Second Session, October 19, 1990; 6 pp. (1990)

This bill was introduced into the U.S. House of Representatives on October 19, 1990. The cleanup of nuclear waste at U.S. Department of Energy facilities must be pursued expeditiously to protect the health and safety of the workers, as well as the public. The waste cleanup and facility modernization will require substantial construction and operational activities and significant long-term funding. The Secretary of Energy may enter into agreements with private contractors for the design, construction, ownership, and operation of facilities if (1) the facilities are provided at the expense of the contractors; (2) the facilities are on or near a federal site under the secretary's jurisdiction; and (3) the facilities support defense waste cleanup, research, management, or facility modernization efforts.

596

C.W. Ariss, J.F. Keck, and K.A. Klossner, EG&G Idaho, Inc., Idaho Falls, ID

**Guidance on Stabilization and Closure of U.S. Department of Energy Mixed and Low-Level Radioactive Waste Disposal Facilities**

DOE/LLW-82; 209 pp. (June 1990)

Recent developments in environmental regulations pertaining to low-level radioactive and radioactive mixed waste disposal and new advances in engineering techniques to secure waste disposal facilities and ensure regulatory compliance have prompted the need for new guidance on stabilization and closure of U.S. Department of Energy (DOE) land disposal facilities. U.S. Environmental Protection Agency (EPA) and U.S. Nuclear Regulatory Commission (NRC) regulations and DOE orders that specify disposal facility closure and postclosure requirements are presented. Technical guidance on closure strategies prepared by these agencies in connection with implementing regulations are presented and interpreted in terms of unique DOE disposal facility management objectives. A standardized method to assess the performance of disposal facilities during their operational and postoperational phases is suggested to aid in meeting disposal facility performance objectives. Newly emerging and innovative engineering methods for stabilizing wastes and disposal sites are presented, along with information necessary to evaluate the merits of individual techniques, given facility-specific conditions. Therefore, this document is intended to provide DOE disposal facility operators with the basic tools and information resources to effectively comply with DOE Order 5820.2A and EPA and NRC regulations.

597

J. Basciectto, U.S. Department of Energy, Office of Environmental Guidance, Washington, DC

**Complying with Land Disposal Restrictions (LDR) for CERCLA Remedial Actions Involving Contaminated Soil and Debris**

DOE/EH-002/0191/CERCLA; 2 pp. (January 1991)

Section 121(e) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requires that remedial actions must comply with at least the minimum standards of all applicable requirements (ARARs) of federal and state laws. The U.S. Environmental Protection Agency (EPA) has determined that Resource Conservation and Recovery Act of 1976 (RCRA) land disposal restrictions may be ARAR for certain CERCLA remedial actions involving soil and debris. This means that soil and debris contaminated with prohibited or restricted wastes cannot be land disposed if (1) these wastes have not attained the treatment standards set by EPA for a specified waste, or (2) they have been the subject of a case-by-case extension, national capacity variance, or successful no-migration petition. RCRA LDR treatment standards are based on the best demonstrated available technology (BDAT), not on health-based concentrations. Because the treatment of the soil and debris matrix presents technological difficulties not yet addressed by EPA (BDAT standards are generally set for industrial process wastes), compliance options such as obtaining a treatability variance are available and will generally be necessary for soil and debris wastes. In the recently promulgated revisions to the national contingency plan for CERCLA implementation, EPA provides important information for CERCLA project managers regarding LDR compliance, particularly for obtaining a treatability variance for land disposal of contaminated soil and debris.

**598**
J.L. Buelt, Pacific Northwest Laboratory, Richland, WA

**Briefing Paper - Remedial Action Assessment System**

PNL-SA-18139; 22 pp. (April 1990)

Congress has mandated a more comprehensive management of hazardous wastes with the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund") and the Superfund Amendment and Reauthorization Act (SARA). This mandate includes restoring of disposal sites contaminated through past disposal practices. It applies to facilities operated for and by the U.S. Department of Energy (DOE), just as it does to industrial and other institutions. To help implement the CERCLA/SARA remedial investigation and feasibility study process in a consistent, timely, and cost-effective manner, a methodology needs to be developed for definition, sorting, and screening of remediation technologies for each operable unit (waste site). This need is stated specifically in Section 2.2.2.1 of the October 1989 DOE Applied Research, Development, Demonstration, Testing, and Evaluation Plan. This briefing paper is prepared to respond to this need.

**599**
G. Burley, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

**Transuranium Elements - Volume 2: Technical Basis for Remedial Actions**

PB-90-262122; EPA/520/1-90/016; 123 pp. (June 1990)

This report consists of two volumes and addresses the problem of environmental contamination by plutonium and other transuranic elements. Volume 2 presents the general background relevant to developing criteria for site-specific remedial action options. The information is intended to provide an overall perspective on the considerations necessary for the decision making process.

**600**
P.J. Cowley and J.C. Brown, Pacific Northwest Laboratory, Richland, WA

**An Integrated Computer-Based System to Facilitate Environmental Monitoring, Assessment, and Restoration**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 276-273) (1990)

The extensive scientific and technical data gathered during environmental monitoring, assessment, and restoration make effective application of a computer-based information system essential. An integrated computer system is being applied at the U.S. Department of Energy Hanford Site to manage data gathered during site characterization and environmental monitoring and to facilitate analysis and assessment. The Hanford Environmental Information System can significantly enhance our ability to manage, retrieve, and display data. Integrating a data base, a geographic information system (that allows data display on a map), and support graphics allows the user to generate spatially related visualizations and to extract data. The user can quickly obtain a complete data picture and easily transfer data to other software environments for further analysis and assessment. We will describe the approach used to design and develop the system, how it was integrated, lessons learned through its development, how it is being used, how it can aid in meeting regulatory requirements, and natural extensions of the system to support environmental restoration.

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**Department of Energy Nuclear Facilities Act of 1989**

U.S. Senate Bill S-1802, Introduced in the Senate of the United States, One Hundredth First Congress, First Session, October 26, 1989; 25 pp. (1989)

This bill enhances nuclear safety at U.S. Department of Energy (DOE) nuclear facilities; apply the provisions of the Occupational, Health, and Safety Act to certain DOE nuclear facilities; encourage independent research on the effects of radiation on human beings; establish a comprehensive program within DOE of research, development, and demonstration of methods for waste cleanup and remediation; and establish a process for ensuring cleanup of DOE nuclear facilities.

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G.W. Eccleston, M.P. Baker, W.R. Hansen, M.C. Lucas, J.T. Markin, and J.R. Phillips, Los Alamos National Laboratory, Los Alamos, NM

**Application of Safeguards Technology in DOE's Environmental Restoration Program**

LA-UR-90-2410; CONF-9007106; Proceedings of the Institute of Nuclear Materials Management Conference, Los Angeles, CA, July 5-19, 1990; (7 pp.) (1990)

During the last two decades, the U.S. Department of Energy Office of Safeguards and Security (DOE/OSS) has supported the research and development of safeguards systems analysis methodologies and nondestructive assay (NDA) technology for characterizing, monitoring, and accounting for nuclear materials. This paper discusses methodologies and NDA instrumentation developed by the DOE/OSS program that could be applied in the Environmental Restoration Program. NDA instrumentation could be used for field measurements during site characterization and to monitor nuclear materials, heavy metals, and other hazardous materials during site remediation. Systems methodologies can minimize the expenditure of resources and help specify appropriate combinations of NDA instrumentation and chemical analyses to characterize a variety of materials quickly and reduce personnel exposure in hazardous environments. A training program is available to teach fundamental and advanced principles and approaches to characterize and quantify nuclear materials properly and to organize and analyze measurement information for decision making. The ability to characterize the overall volume and distribution of materials at a waste site is difficult because of the inhomogeneous distribution of materials, the requirement for extreme sensitivity, and the lack of resources to collect and chemically analyze a sufficient number of samples. Using a systems study approach based on statistical sampling, the resources necessary to characterize a site can be enhanced by appropriately combining in situ and field NDA measurements with laboratory analyses.

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W.E. Fallon, J.M. Gephart, R.E. Gephart, R.D. Quinn, and L.A. Stevenson, Pacific Northwest Laboratory, Richland, WA

**Regulatory and Institutional Issues Impending Cleanup at U.S. Department of Energy Sites: Perspectives Gained from an Office of Environmental Restoration Workshop**

PNL-7692; 133 pp. (May 1991)

The U.S. Department of Energy's (DOE) nuclear weapons and energy operations are conducted across a nationwide industrial complex engaged in a variety of manufacturing, processing, testing, and research and development activities. The overall mission of DOE Office of Environmental Restoration and Waste Management (EM) is to protect workers, the public, and the environment from waste materials generated by past, current, and future DOE activities and to bring the DOE complex into compliance with all applicable laws, regulations, and agreements related to health, safety, and the environment. EM addresses this broad mandate through related and interdependent programs that include corrective actions, waste operations, environmental restoration, and technology development. The EM Office of Environmental Restoration (EM-40) recognizes the importance of implementing a complex-wide process to identify and resolve those issues that may impede progress towards site cleanup. As a first step in this process, EM-40 sponsored an exercise to identify and characterize major regulatory and institutional issues and to formulate integrated action steps towards their resolution. This report is the first product of that exercise. It is intended that the exercise described here will mark the beginning of an ongoing process of issue identification, tracking, and resolution that will benefit cleanup activities across the DOE complex.

**604**

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**Impacts of Recent Regulations or Changes in Regulations on DOE Remedial Action Programs**

CONF-880903; Spectrum '88: Nuclear and Hazardous Waste Management, Proceedings of an International Topical Meeting, Pasco, WA, September 11-15, 1988. American Nuclear Society, La Grange Park, IL, 630 pp.; (pp. 124-126) (1988)

The U.S. Department of Energy Office of Remedial Action and Waste Technology is responsible for several remedial action programs, including the Formerly Utilized Sites Remedial Action Program, the Surplus Facilities Management Program, and the Uranium Mill Tailings Remedial Action Program. The first two programs are managed by the Division of Facility and Site Decommissioning Projects and the latter by the Division of Uranium Mill Tailings Projects. The remedial action projects have been underway since the 1970s, and recent changes in environmental guidance and regulations have resulted in some changes to implementation procedures and project plans. In this paper three areas of regulatory activity that have impacted or have potential to impact the implementation of these programs either directly or indirectly are discussed.

**605**

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**Use of USRADS System for Real Time Radiation Survey Measurements for Depleted Uranium Environmental Contamination**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 603-607) (March 1989)

The Ultrasonic Ranging and Data Systems (USRADS) was used to quickly perform detailed repetitive radiation surveys supporting a hazards assessment program for a series of munitions tests that dispersed depleted uranium to the surrounding environs. With this system, the surveyor walks at a normal pace over the site and USRADS automatically transmits the survey instrument data reading via radio frequency to a nearby microcomputer once per second. In the same second, an ultrasonic signal from the surveyor is used to generate time-of-flight data that the microcomputer uses to determine the surveyor position to about plus or minus 15 centimeters. The resulting data and corresponding location is displayed on the computer video screen as a point within the grid defined by the survey boundary area and automatically stored on the computer disk each second. If the measurement data exceeds a user-specified threshold value, such as background plus 20%, the location point shown on the cathode-ray tube is increased in size to produce a highlighted square on the screen, rather than a dot. The accumulation of these data locations on the screen show the sequence of the actual surveyor path, or Track Map, in real time, at a rate of 3600 points per hour of survey time. Individual highlighted location points indicate a small source is present in the area, while a clustering of highlighted points indicates an area source is present above the specified threshold. This comprehensive data collection method allowed for immediate on-site analysis of the results in presentation schemes that are either not reasonably affordable with conventional survey methods or simply not feasible. Correlation with soil samples show that USRADS can easily identify 50 pCi/g of depleted uranium in soil contamination, and possibly levels of below 30 pCi/g. This paper presents the summary results of the USRADS analyses performed at the test site.

**606**

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**Real-Time Environmental Surveys for Site Investigations and Characterizations with USRADS**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 367-371) (1990)

The Ultra Sonic Ranging And Data System (USRADS) has been connected to a number of different contaminant detection devices to provide real-time surveys in the conduct of site characterizations. USRADS was originally developed to provide automated data location and logging of radioactive contamination resulting from uranium mining and milling activities. With USRADS, the real-time detector reading is sent via radio link to a near-site personal computer once each second. The computer determines the surveyor location via ultrasonics, plots the surveyor position along with an indication of the value of the corresponding detector reading on the computer monitor, and stores the data on disk for further analysis. Because the sampling rate of once per second corresponds to a normal walking speed of roughly once per 3 ft, the USRADS-generated data density over a site greatly exceeds that of conventional methods and provides real-time data presentation not otherwise available. Added benefits include field reassessment of the data and field-generated printouts for biasing and locating samples. Efforts are continuing to interface USRADS for use with different types of radiological and nonradiological detectors that are used for site investigation and characterization One such effort involves soil conductivity measurements. Through this adaptation, a walkover survey reveals the variation in soil conductivity at depths up to 18 ft belowgrade. Interpretation of the results can indicate the presence, size, and location of trenches and buried objects such as drums, pipelines, and tanks. Another effort combines USRADS with a portable x-ray fluorescence analyzer for identification of heavy metal contaminants such as lead, zinc, and mercury in surface soil. The most recent USRADS enhancement is to interface with a microRoentgen meter to measure and map the dose rate at the same time soil contamination is surveyed. Still another effort is directed at making quantitative determination of gamma photon energy spectra for radiation dose measurements below ambient background levels. This effort is in response to current International Atomic Energy Agency and International Commission on Radiological Protection recommendations for release of decontaminated facilities. This paper presents the findings of these and related efforts.

**607**

J.M. Forstrom, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

**Strategy for Conducting Environmental Surveillance of Groundwater to Comply with DOE Orders**

ES/ESH-17; 41 pp. (December 1990)

This document defines the strategy for conducting environmental surveillance of groundwater quality at U.S. Department of Energy installations as it will be implemented by Martin Marietta Energy Systems, Inc. The primary objectives of defining this generic strategy before developing site-specific plans are (1) to clearly differentiate between effluent monitoring and environmental surveillance as they apply to groundwater, (2) to describe the principles and concepts of groundwater flow that

must be considered when establishing a groundwater surveillance program, and (3) to provide for a consistent approach to developing plant-specific groundwater surveillance plans.

**608**

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**Research and Development in Support of the Five-Year Plan**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 95-100) (1990)

To support its 20-year cleanup goal and significantly reduce program cost, the U.S. Department of Energy (DOE) has committed to increase its investment in, and coordinate its management of Applied Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) to resolve existing technical issues and rapidly advance beyond currently available waste management and waste site cleanup technologies. DOE has established a national RDDT&E program that will include involvement of DOE Operations Offices, national laboratories, other federal agencies, universities, and industry and that will seek the advice of external advisory and technical review groups. This paper describes a plan that clearly maps out a time-phased, needs-driven RDDT&E program to provide technologies over the next two decades for the safe, expeditious, and economical completion of DOE site environmental restoration and improved waste management.

**609**

C.W. Frank and R.P. Whitfield, U.S. Departm‹ ‹. . ‹ Energy, Office of Technology Develop‹ ‹ent, Washington, DC; U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Call for Participation in Planned DOE-Wide D&D Workshop**

Correspondence; 6 pp. (May 7, 1991)

The Office of Technology Development and the Office of Environmental Restoration of the U.S. Department of Energy (DOE) have undertaken a joint initiative to conduct possible integrated decontamination and decommissioning (D&D) demonstrations to generate technology needed throughout DOE to carry out anticipated D&D activities. The first step is to establish D&D research, development, demonstration, testing, and evaluation needs and deficiencies. Toward this objective, a workshop is to be held July 16-18, 1991, in Oak Ridge, Tennessee. The workshop will be designed to answer four questions: (1) what are the D&D needs and issues, (2) what are the current practices, (3) what technologies are applicable to satisfy their needs, and (4) what technology development is needed to fill in the gaps? Participation in the workshop is desired from all DOE field offices, DOE contractors and private firms having D&D technology needs or development capabilities. Presentations summarizing these needs and capabilities are desired and all participants will be expected to be able to discuss them. The ultimate product of the workshop will be a recommendation for future D&D-integrated demonstration activities. The workshop will be organized to address technology corresponding to these D&D categories: (a) characterization of equipment, buildings, and wastes; (b) equipment, buildings, and structures decontaminated, including methodologies, chemistries, and secondary waste management; (c) building and equipment dismantling, including worker protection, contamination containment, and special problems associated with high radiation areas; (d) remotization and smart systems, including data and material tracking; and (e) material disp‹ ‹ition, including waste disposal and sale and reuse ‹ f valuable materials.

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**Introducing New Technologies Into Today's Cleanup Arena**

PNL-SA-19148; CONF-910270; Waste Management '91: Working Towards a Cleaner Environment - High-Level Waste, Low-Level Waste, Mixed Waste and Environmental Restoration, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 24-28, 1991; (13 pp.) (February 1991)

The introduction of new technologies into the environmental cleanup arena has proven to be time-consuming, expensive, and encumbered by many institutional, regulatory, and technical obstacles. Therefore, cleanup contractors and regulators have tended to rely on established, historically proven technologies even though more effective approaches are needed. This paper addresses some of the key issues facing the industry and the federal agencies in their attempts to use new technologies to meet expanding environmental management needs.

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**The Cost of Remedial Actions (CORA) Model - Application to the U.S. Department of Energy's (DOE's) Environmental Restoration Program**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 391-395) (1990)

This paper provides an overview of the Cost of Remedial Actions (CORA) model and reviews current and potential applications to the U.S. Department of Energy (DOE) Environmental Restoration Program. The CORA model estimates site-specific remedial action costs for Superfund sites. The model is microcomputer-based and has two components: (1) an expert system and (2) a cost system. The expert system interacts with the user to develop a range of reasonable response actions. The cost system contains algorithms capable of developing order-of-magnitude cost estimates for 40 technologies. The CORA model has been used successfully in a number of different applications. The model was used to develop cost estimates for 97 Superfund sites considered to be possible FY 1989 remedial action candidates. The U.S. Environmental Protection Agency used these cost estimates in the development of the FY 1989 Superfund remedial action budget. The model was also recently applied to 661 Navy Installation Restoration Program sites for use in developing FY 1989, 1990, and 1991 remedial action budgets. In addition, the model has been used for economic analysis of the Resource Conservation and Recovery Act Location Standards Rule and for preliminary scoping and budgeting for several National Priorities List sites. The model has applications in both site-specific scoping and budgeting and out-year budget estimating. In addition, the potential exists for use in predicting programmatic remediation costs for federal and state agencies and other parties and for estimating interim actions and specific remediation components such as removals. The CORA model is currently designed to address only sites contaminated with hazardous waste. However, recent data indicate that approximately 30% of existing DOE sites are contaminated solely with hazardous wastes. Additional revisions to the model are required to make it applicable to mixed waste and radioactive waste sites.

612
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**Environmental Monitoring, Restoration and Assessment: What Have We Learned?**

PNL-SA-18876; CONF-891053; Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp. (1990)

The Twenty-Eighth Hanford Symposium on Health and the Environment was held in Richland, Washington, October 16-19, 1989. The symposium was sponsored by the U.S. Department of Energy and Pacific Northwest Laboratory, operated by Battelle Memorial Institute. The symposium was organized to review and evaluate some of the monitoring and assessment programs that have been conducted or are currently in place. Potential health and environmental effects of energy-related and other industrial activities have been monitored and assessed at various government and private facilities for over three decades. Most monitoring is required under government regulations; some monitoring is implemented because facility operators consider it prudent practice. As a result of these activities, there is now a substantial radiological, physical, and chemical data base for various environmental components, both in the United States and abroad. Symposium participants, both platform and poster presenters, were asked to consider, among other topics, the following: Has the expenditure of millions of dollars for radiological monitoring and assessment activities been worth the effort? How do we decide when enough monitoring is enough? Can we adequately assess the impacts of nonradiological components - both inorganic and organic - of wastes? Are current regulatory requirements too restrictive or too lenient? Can monitoring and assessment be made more cost effective? Papers were solicited in the areas of (1) environmental monitoring; (2) environmental regulations; (3) remediation, restoration, and decommissioning; (4) modeling and dose assessment; (5) uncertainty, design, and data analysis; and (6) data management and quality assurance. Individual reports from the symposium are recorded separately.

**613**

S. Green, Jacobs Engineering Group, Inc., St. Charles, MO

### A Field Study Designed to Select the In-Situ Instrument Most Useful for Estimating Uranium Concentration in Soil

Report; 19 pp. (1987)

A requirement for any remedial action involving a site contaminated with radionuclides from the natural series is a field instrument capable of quickly estimating land areas that exceed cleanup guidelines. Much work has been done on uranium mill tailings sites in which a major contaminant was Ra-226. Considering the high-energy gamma radiation emitted by Ra-226 daughter products, it is not surprising that detector configurations using a NaI scintillator operating in a gross count mode have proven quite useful. Remedial actions are now under way on sites primarily contaminated with uranium not in secular equilibrium with its daughter products (limited Ra-226). In this situation, the choice of the proper field instrument becomes less clear. This paper presents the results of a field study designed to select the instrument most appropriate for detecting uranium in excess of remedial guidelines. The instruments tested were a shielded pancake geiger-mueller detector, a field instrument for detecting low energy radiation operated in the gross count mode and the single channel mode, and an unshielded 2-in. X 2-in. NaI scintillometer. It is concluded that the unshielded 2-in. X 2-in. NaI scintillometer provides the most accurate and precise means of estimating uranium concentrations in soil. In addition, its use minimizes the probability of excavating soil having natural background radionuclide concentrations.

**614**

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### Initial Robotics Research for Environmental Restoration and Waste Management

CONF-900608; Proceedings of the American Nuclear Society 1990 Annual Meeting, Nashville, TN, June 10-14, 1990; (2 pp.); Transactions of the American Nuclear Society 61:416-417 (June 1990)

This paper describes the initial research and development activities at the Oak Ridge National Laboratory (ORNL) that will support the technology development component of the overall National Robotics Technology Development Program (NRTDP). NRTDP is part of the U.S. Department of Energy (DOE) Environmental Restoration and Waste Management five-year applied research, development, demonstration, testing, and evaluation plan and of overall efforts at DOE operational sites around the country. ORNL research will focus on fundamental improvement of remote manipulation through enhancements of the human/machine interface, integration of automated functions, and the incorporation of machine intelligence to increase productivity. Background and goals for these activities are presented in this paper.

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**MEPAS (Multimedia Environmental Pollutant Assessment System) and RAAS (Remedial Action Assessment System) Methodologies as Integrated into the RI/EA/FS Process**

CONF-881141; Superfund '88: Hazardous Waste, Proceedings of the Ninth National Conference and Exhibition, Washington, DC, November 28-30, 1988, 659 pp.; (pp. 295-299) (1988)

To help implement the remedial investigation, endangerment assessment, and feasibility study processes in a more consistent, timely, and cost-effective manner, the Multimedia Environmental Pollutant Assessment System (MEPAS) and the Remedial Action Assessment System (RAAS) can be integrated into the process to (1) focus on and prioritize the environmental issues at a waste unit, and (2) screen remedial alternatives (synthesized from between 100 and 150 treatment technologies) to ensure that the appropriate environmental issues are addressed and that only the most appropriate remedial alternatives are highlighted for final consideration. The MEPAS methodology is a user-friendly, computer-based endangerment assessment-type system designed to assess environmental issues and problems on the basis of limited site data by performing a physics-based transport, exposure, and health effects assessment. The RAAS methodology is a feasibility study assessment methodology (currently under development) that investigates remedial action alternatives by (a) integrating unit processes into treatment trains, (b) evaluating each remedial alternative with respect to performance, and (c) evaluating the potential risk to surrounding sensitive receptors (using the MEPAS methodology) for waste streams associated with each remedial alternative.

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**Use of Computer Models to Determine Environmental Compliance, Predict Performance, and Assess Impacts of DOE Facilities**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 225-230) (1990)

Mathematical models are widely used to answer questions that cannot easily be addressed otherwise. Environmentally focused computer programs have been developed for various purposes: (1) to predict the long-term performance of repositories, (2) to estimate acute effects from accidental releases of hazardous materials, (3) to demonstrate compliance with federal regulations, and (4) to evaluate effects of environmental releases of hazardous materials. Relying solely on computer programs to provide assessments for these four purposes places us in a potentially vulnerable position. Thus, we must ask what steps should be taken to ensure the accuracy and reasonableness of computer-program-derived assessments. Is there a place for common sense in checking the output of extremely complex models? Should the application determine what effort is necessary to ensure the model is performing as desired? We will suggest criteria for the development, selection, and use of environmental computer models. These criteria will be compared for two situations: (a) using a model to demonstrate compliance with the radionuclide emission standards in 40 CFR Part 61; and (b) using a model as a scientific tool to evaluate effects from environmental releases of radioactive materials. Validation, verification, calibration, and quality assurance will be addressed for specific model applications.

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**Impact of CERCLA Reauthorization on Federal Facilities**

CONF-880437; Proceedings of the Fifth Annual Hazardous Materials Control Research Institute Conference, Las Vegas, NV, April 19-21, 1988, 583 pp.; (pp. 501-504) (1988)

The U.S. Environmental Protection Agency (EPA) Administrator has stated that federal facility compliance with pollution control regulations should be a model for the rest of the regulated community and that federal facilities should lead the way in minimizing environmental contamination. In addition, during the past few years, the issue of controlling pollution from federal facilities has received much publicity in the media and in Congress. This paper highlights federal agency requirements to address hazardous waste problems resulting from past practices and describes initiatives by EPA to ensure that compliance with these requirements is achieved.

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**The Role of Risk Assessment in Environmental Programs**

CONF-881054 (Vol. 2); Proceedings of the 1988 DOE Model Conference, Oak Ridge, TN, October 3-7, 1988, Vol. 2, 329 pp.; (pp. 685-694) (1988)

The requirements for management and remediation at sites where hazardous, radioactive, and mixed wastes have been handled are governed by numerous regulations. To satisfy the programmatic requirements instituted by environmental regulations and to be responsive to public concerns, one must structure the waste management program for these sites in an organized manner. This requires that the management program be presented clearly and accurately, integrating accepted scientific findings with the current regulatory requirements and public concerns to obtain acceptance. This paper addresses the role of performance assessment in establishing a framework to respond to an uncertain regulatory environment. Performance assessment can be used to address three fundamental questions, namely (1) what can go wrong (source); (2) what is the likelihood of this event (release); and (3) what are the consequences (pathways, receptor). The paper concludes with an example of how performance assessment can be applied throughout the life cycle of a low-level radioactive waste disposal facility.

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**An Environmental ALARA (As-Low-As-Reasonably-Achievable) Methodology for Assessing a Soil Cleanup Action**

CONF-900608; Proceedings of the American Nuclear Society 1990 Annual Meeting, Nashville, TN, June 10-14, 1990; (3 pp.); Transactions of the American Nuclear Society 61:35-37 (June 1990)

The purpose of this paper is to present a methodology for performing an environmental as-low-as-reasonably-achievable assessment for soil cleanup initiatives. Radioactive contamination of the environment is a problem at many nuclear weapons plants across the country. Often the contamination at these sites is concentrated in small areas. Prior to the completion of any sitewide remedial investigations or feasibility studies, soil removal actions are usually performed. These soil removal actions usually consist of soil sampling and measurement, excavation, and postexcavation sampling and measurement. The crucial question that arises in the soil removal initiative is the concentration level that should be achieved in the soil removal cleanup action. The methodology presented here consists of determining the health effects from existing levels

of radionuclides in the soil of a small contaminated region and then determining the cost/benefit analysis of the soil removal action. Performing this type of analysis can guide the soil removal actions and greatly decrease the final cleanup costs.

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**Operational Requirements of the Environmental Restoration and Waste Management Five-Year Plan at Department of Energy Sites**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 119-123) (1990)

The U.S. Department of Energy (DOE) has committed to achieving compliance with environmental laws and regulations, cleaning up and restoring its nuclear sites, and accomplishing this in an open and participatory manner. The Environmental Restoration and Waste Management Five-Year Plan documents the process through which these goals will be achieved and is the reference against which progress towards achieving these goals will be achieved. The waste management operations program has the responsibility to safely manage the radioactive, hazardous, mixed and sanitary waste from DOE's nuclear activities. DOE has large quantities of waste that have been stored for future treatment and disposal. DOE defense and nuclear research and development activities continue to generate waste that must be safely and effectively managed. The Five-Year Plan describes activities and facilities that must be put in place to have an effective treatment, storage, and disposal method for each waste type. This must be accomplished within resource constraints and within a complex regulatory framework.

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**Applicable or Relevant and Appropriate Requirements (ARAR) for Radioactive Mixed Waste**

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 91-99) (1990)

The environmental pollution control and radioactive waste-management statutes and regulations that might contain applicable or relevant and appropriate requirements (ARAR) as defined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are reviewed. These requirements apply to four exposure pathways: (1) air, (2) groundwater, (3) surface water, and (4) soil. A framework is provided to integrate the chemical- and radioactive-waste management requirements for these pathways. Examples of mixed-waste management scenarios are given to illustrate the application of this framework to waste management and/or cleanup decision making.

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**Achieving Consensus in Environmental Programs**

CONF-890207 (Vol. 1); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - High-Level Waste and General Interest, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 1, 857 pp.; (pp. 113-117) (March 1989)

In this paper, a new research effort on consensus tied to the Environmental Restoration (ER)

Program within the U.S. Department of Energy (DOE) Office of Defense Waste and Transportation Management (DWTM) is described. The author define consensus and explain why consensus decisions are not merely desirable but necessary in furthering ER Program activities. As examples of planned applied research, Nominal Group Technique as a representative consensus-generating tool is first discussed, and in conclusion, a description the consensus-related mission of the Waste Management Review Group established at Virginia Tech to conduct independent, third-party review of DWTM/ER Program plans and activities are given. The key definitive feature of the organizations responsible for ER Program activities is not autonomy, but polyonomy, a term invented to signify the diffusion of responsibility among many agencies and subagencies. DOE is a Government Oversight Agency (GOA). GOAs at all levels of government (federal, state, and local) must implement laws made by Congress and by state legislatures and must coordinate their overlapping roles and responsibilities. Further they must learn to cooperate in an arena that rewards adversarial behavior, and they must learn to maintain this cooperation over long periods, to adapt to inevitable change.

**623**

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### Integrating NEPA and CERCLA Requirements During Remedial Responses at DOE Facilities

ORNL/TM-11564; 60 pp. (July 1990)

U.S. Department of Energy (DOE) Order 5400.4, issued October 6, 1989, calls for integrating the requirements of the National Environmental Policy Act (NEPA) with those of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for DOE remedial actions under CERCLA. CERCLA requires that decisions on-site remediation be made through a formal process called a remedial investigation/feasibility study (RI/FS). According to the DOE order, integration is to be accomplished by conducting the NEPA and CERCLA environmental planning and review procedures concurrently. The primary instrument for integrating the processes is to be the RI/FS process, which will be supplemented as needed to meet the procedural and documentational requirements of NEPA. The final product of the integrated process will be a single, integrated set of documents; namely, an RI report and an FS-Environmental Impact Statement (EIS) that satisfy the requirements of both NEPA and CERCLA. The contents of the report include (1) an overview and comparison of the requirements of the two processes; (2) descriptions of the major tasks included in the integrated RI/FS-EIS process; (3) recommended contents for integrated RI/FS-EIS documents; and (4) a discussion of some potential problems in integrating NEPA and CERCLA which fall outisde the scope of the RI/FS-EIS process, with suggestions for resolving some of these problems.

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S.C.T. Lien, S.S. Borys, and M.D. Erickson, Argonne National Laboratory, Argonne, IL

### U.S. Department of Energy Applied R&D Private Sector Initiatives

CONF-9005271; Hazardous Waste Research, Proceedings of the 1990 Conference, Manhattan, KS, May 21-22, 1990; (24 pp.) (1990)

The Department of Energy (DOE) has recently consolidated its Environmental Restoration and Waste Management activities. Within that new organization, DOE has committed to conduct Research, Development, Demonstration, Testing, and Evaluation activities within the Office of Technology Development to reduce cost, reduce risk, and otherwise improve the technologies to meet its cleanup goals. Currently available technology is not adequate to assess environmental contamination, take permanent remedial action, and to eliminate or minimize the environmental impact of future operations. To focus private sector capabilities on the high-priority needs of DOE, a series of competitive solicitations will be issued starting in FY 1990. This paper describes the range and scope of the DOE initiatives for

private sector involvement in applied research and development.

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T.P. Longo, R.P. Whitfield, T.A. Cotton, and M.W. Merkhofer, U.S. Department of Energy, Washington, DC

**DOE's Formal Priority System for Funding Environmental Cleanup**

Federal Facilities Environmental Journal 1(2):219-232

The U.S. Department of Energy (DOE) has overseen the production of nuclear materials and weapons for over 40 years, resulting in sites and facilities that must be evaluated for contamination. To maximize public resources, DOE has been systematically planning and budgeting for the restoration of these sites. The system of prioritization is based on principles of risk analysis and multiobjective decision theory. The results should facilitate allocation and justification of budget resources to DOE cleanup projects.

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**The Department of Energy's National Robotics Technology Development Program for Environmental Restoration and Waste Management**

CONF-900608; Proceedings of the American Nuclear Society 1990 Annual Meeting, Nashville, TN, June 10-14, 1990; (1 pp.); Transactions of the American Nuclear Society 61:414 (June 1990)

In August 1989, the new U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management (ER&WM) published an ER&WM Five-Year Plan, which establishes DOE's agenda and commitment to correct existing environmental problems; ensure compliance with applicable federal, state, and local requirements; and effectively execute DOE's waste management programs. The plan includes a section covering the applied research and development (R&D) needed to support the Five-Year Plan. In November 1989, DOE issued a draft Applied Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) Plan for ER&WM, which expands on the applied R&D section of the Five-Year Plan. The RDDT&E Plan provides guidance to the new ER&WM Office of Technology Development (OTD) for its mission. The development and application of robotics technology for the resolution of identified problem areas at DOE sites is a major element of the RDDT&E program plan. The OTD has established a National Robotics Technology Development Program to integrate robotics RDDT&E activities and to provide needs-oriented, timely, and economical robotics technology to support environmental and waste operations activities at DOE sites.

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M.W. Merkhofer, T.A. Cotton, K.E. Jenni, J.C. Lehr, and T.P. Longo, Applied Decision Analysis, Inc., Menlo Park, CA; JK Associates, Inc., Silver Spring, MD; U.S. Department of Energy, Defense Programs Hazardous Waste and Remedial Actions Division, Washington, DC

**A Program Optimization System for the Cleanup of DOE Hazardous Waste Sites: An Application to FY 1990 Funding Decisions**

CONF-890207 (Vol. 2); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Low-Level Waste, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 2, 844 pp.; (pp. 149-158) (March 1989)

This paper describes a formal system used by DOE as an aid for allocating funds for cleaning up hazardous waste sites. The system, called the Program Optimization System (POS) is based on multiattribute utility analysis and was developed for the U.S. Department of Energy (DOE) Hazardous Waste and Remedial Actions Division

(HWRAD). HWRAD has responsibility for recommending Environmental Restoration (ER) activities to the Assistant Secretary of Energy. Recently, the POS was used to analyze and recommend funding levels for FY 1990 cleanup activities at DOE Defense Program facilities. The numerical results displayed in this paper represent the second, revised FY 1990 application and differ slightly from those presented in an earlier paper based on the initial application, conducted to help establish the total ER budget request early in the budgetary planning cycle.

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National Technical Information Service, Springfield, VA

**Radioactive Waste Storage Sites: Reclamation and Remedial Action - Report for January 1970-July 1989**

PB-89-867741; 123 pp. (August 1989)

This bibliography contains citations concerning remedial action programs designed to restore sites contaminated with radioactivity. Priority determination for remedial action, cleanup techniques, site surveys, site characterization and identification, environmental impacts of remedial action, technology for containment of contaminated materials, and programs and plans for eventual reclamation of existing facilities are among the topics discussed. Techniques of radioactive waste solidification, fixation, and vitrification are discussed in separate bibliographies.

**629**

A.E. Norris, Los Alamos National Laboratory, Los Alamos, NM

**Opportunities for Health and Safety Professionals in Environmental Restoration Work**

LA-UR-91-1295; CONF-9104204; Waste Management, Proceedings of the First Engineering and Technology Conference, San Juan, Puerto Rico, April 24-26, 1991; (8 pp.) (1991)

The safety of workers in waste management and in environmental restoration work is regulated in large part by the Occupational Safety and Health Administration (OSHA). Many of the OSHA rules are given in Part 1910, Occupational Safety and Health Standards, of Title 29 of the Code of Federal Regulations (CFR). Section 120 of 29 CFR 1910 specifically addresses hazardous waste operations and emergency response operations. The remainder of this discussion focuses on cleanup operations. The purpose of this paper is to review areas of employment opportunity in environmental restoration work for health and safety professionals. Safety and health risk analyses are mentioned as one area of opportunity, and these analyses are required by the standards. Site safety and health supervisors will be needed during field operations. Those who enjoy teaching might consider helping to meet the training needs that are mandated. Finally, engineering help both to separate workers from hazards and to improve personal protective equipment when it must be worn would benefit those actively involved in environmental restoration activities.

**630**

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**An Automated Locating and Data Logging System for Geophysical Surveys**

CONF-9005149; Aquifer Restoration, Groundwater Monitoring, and Geophysical Methods, Proceedings of the Fourth National Outdoor Action Conference, Las Vegas, NV, May 14-17, 1990, 1333 pp.; (pp. 99-113) (1990)

Oak Ridge National Laboratory has developed an Ultrasonic Ranging and Data System (USRADS) and interfaced the system with a Geonics EM31 terrain conductivity meter. USRADS keeps track of a surveyor's position by measuring the time-of-flight of ultrasonic pulses from an transducer carried by the surveyor in a backpack to stationary receivers arrayed over the survey area. Also built into the backpack is a radio transmitter that sends the EM31 data to a base station (van or truck) where the surveyor's position and the EM31 quadrature and in-phase data are automatically recorded once per second on a portable computer.

A 13-acre landfill at Idaho National Engineering Laboratory was surveyed by three people, in three days, collecting over 25,000 EM31 quadrature and in-phase readings. At a normal walking pace the average distance between measurement points along the surveyor's path was about 2 ft, with an overall positioning precision of about 0.5 ft for each point. USRADS offers several advantages over conventional EM31 surveys: (1) time and money are saved because it does not require a civil survey to lay a grid before the geophysical survey begins, (2) data are directly recorded by a portable computer and are available for analysis in the field, and (3) refining or expanding the grid about an anomaly does not require civil surveying to add extra grid points. USRADS can also be used with a gamma scintillometer for radiation surveys. Currently, work is being done to interface USRADS with a portable X-ray fluorescence spectrometer for detecting heavy metals in soil.

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Oak Ridge K-25 Site, Oak Ridge, TN

**Proceedings of the U.S. Department of Energy, Office of Environmental Restoration and Waste Management Sixth Waste Reduction Workshop**

DOE/HWP-108; CONF-9102116; Proceedings of the Sixth Waste Reduction Workshop, Atlanta, GA, February 6-7, 1991, 322 pp. (April 1991)

The sixth of a series of waste reduction workshops was held at the Airport Hilton Hotel in Atlanta, Georgia, on February 6-7, 1991. These workshops are held under the auspices of the U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management. The focus of this workshop was the review of guidance and the status of conducting process waste assessments (PWAs). Other highlights of the workshop were the status of the Environmental Protection Agency Pollution Prevention Program and presentations on budgeting for waste reduction and the impact of the toxic release inventory reporting requirements on pollution prevention activities. Concurrent sessions on the second day included case studies of the experiences at various sites on the subjects of recycling, incentives, source reduction, volume and toxicity reduction, and material procurement. The impact of new state laws on waste reduction efforts at Oak Ridge, Lawrence Livermore National Laboratory, and Hanford were also reviewed by representatives from those sites. These workshops assist DOE waste-generating sites in implementing waste minimization plans and programs, thus providing for optimal waste reduction within the DOE complex. All wastes are considered - liquid, solid, and airborne - within the categories of high-level waste, transuranic waste, low-level waste, hazardous waste, mixed waste, office waste, and sanitary wastes. Topics of discussion within workshops encompass a wide range of subjects, including any method or technical activity from waste generation to disposal such as process design or improvement, substitution of materials, waste segregation and recycling/reuse, waste treatment and processing, and administrative controls (procurement and waste awareness training). Consideration is also given to activities for remedial action and for decontamination and disposal.

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Oak Ridge National Laboratory, Oak Ridge, TN

**Integrated Data Base for 1990: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics**

DOE/RW-0006 (Rev. 6); 319 pp. (October 1990)

The Integrated Data Base Program has compiled in this report current data on inventories and characteristics of commercial spent fuel and both commercial and U.S. Government-owned radioactive wastes through December 31, 1989. These data are based on the most reliable information available from government sources, the open literature, technical reports, and direct contacts. The current projections of future waste and spent fuel to be generated through the year 2020, and characteristics of these materials, are also presented. The information forecasted is consistent with the latest DOE/Energy Information Administration projections of U.S. commercial nuclear power growth and both the expected

DOE-related and private industrial and institutional activities. The radioactive materials considered on a chapter by chapter basis in this report are (1) spent fuel, (2) high-level waste, (3) transuranic waste, (4) low-level waste, (5) commercial uranium mill tailings, (6) environmental restoration wastes, (7) commercial reactor and fuel cycle facility decommissioning wastes, and (8) mixed (hazardous and radioactive) low-level waste. For most of these categories, current and projected inventories are given through the year 2020, and the radioactivity and thermal power are calculated based on reported or estimated isotopic compositions. In addition, characteristics and current inventories are reported for miscellaneous radioactive materials that may require geologic disposal.

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R.G. Post (ed.), University of Arizona, College of Engineering and Mines, Tucson, AZ

**Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Volume 1: Overview and General Waste Management**

CONF-900210 (Vol. 1); Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1; 813 pp. (1990)

This volume contains about 123 papers on radioactive waste management. Topics include U.S. and international waste management programs, environmental restoration plans, transportation of nuclear waste, remedial actions, regulations and standards, risk assessment, policy formation, and mixed waste issues. Individual papers from the conference which pertain to environmental restoration, remedial actions, nuclear facility decommissioning, and specific U.S. Department of Energy programs related to these activities are indexed separately and receive their own abstracts.

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R.G. Post (ed.), University of Arizona, College of Engineering and Mines, Tucson, AZ

**Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Volume 2: HLW and LLW Technology**

CONF-900210 (Vol. 2); Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 2; 988 pp. (1990)

This volume contains about 131 papers on high-level radioactive waste (HLW) and low-level radioactive waste management technology. Topics primarily related to low-level waste include characterization and classification, processing, packaging, transportation containers, certification standards, licensing and regulation of disposal facilities, and remedial action experience. High-level waste topics include HLW technology; spent-fuel management; the Yucca Mountain project; characterization, processing, storage, disposal, and regulation of HLW and transuranic wastes; package design and performance; and hydrogeologic considerations of disposal. Individual papers from the conference which pertain to environmental restoration, remedial actions, nuclear facility decommissioning, and specific U.S. Department of Energy programs related to these activities are indexed separately and receive their own abstracts.

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V.S. Rezendes, General Accounting Office, Resources, Community and Economic Development Division, Washington, DC

**Correcting Environmental Problems Facing the Nuclear Weapons Complex**

GAO/T-RCED-90-J85; 13 pp. (June 1990)

This report discusses DOE's efforts to correct the environmental problems facing the nuclear weapons complex. It focuses on three main points. First, the weapons complex faces a variety of serious and costly environmental problems. Second, during the past year, DOE has made some important changes to its organization that should help change its management focus from one that emphasizes materials production to one that more clearly focuses on environmental concerns. Third, because resolution of DOE's environmental problems will require considerable resources during a period of budgetary constraints, it is imperative that DOE have internal controls in place to ensure that resources are spent efficiently.

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**DOE's Efforts to Correct Environmental Problems of the Nuclear Weapons Complex**

GAO/T-RCED-90-47; 14 pp. (March 1990)

This report focuses on four main issues: (1) the environmental problems at the U.S. Department of Energy (DOE) nuclear weapons complex, (2) recent changes in DOE organizational structure, (3) DOE's 1991 budget request, and (4) the need for effective management systems. This report concludes that the environmental problems are enormous and will take decades to resolve. Widespread contamination can be found at many DOE sites, and the full extent of the environmental problems is unknown. DOE has taken several steps during the past year to better deal with these problems, including making organizational improvements and requesting additional funds for environmental restoration and waste management activities.

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B.S. Richardson, S.M. Killough, M.S. Emery, J.N. Herndon, W.R. Hamel, and B.L. Burks, Oak Ridge National Laboratory, Oak Ridge, TN

**Remote Site Survey and Characterization for the National ER&WM Program Using the SRIP Vehicle**

Remote Systems Technology, Proceedings of the 38th Conference, Washington, DC, November 1990. American Nuclear Society, La Grange Park, IL, Vol. 2; (pp. 49-53) (1990)

A significant number of U.S. Department of Energy production and research sites will require remediation of buried-waste sites during the coming years. An important first step in cleanup, restoration, and decontamination activities is burial-site characterization. An early field demonstration of buried-waste site survey and characterization will be conducted using a remotely operated vehicle equipped with sensors, a manipulator system, and a vision system. This demonstration will be conducted in July 1990.

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R.E. Sanderson and J.R. Edward, U.S. Environmental Protection Agency, Office of Federal Activities, Washington, DC

**Ensuring Day-to-Day Compliance by Federal Agencies: EPA's Federal Facilities Compliance Program**

CONF-890207 (Vol. 1); Waste Management '89: Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - High-Level Waste and General Interest, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 26-March 2, 1989, Vol. 1, 857 pp.; (pp. 95-98) (March 1989)

There is an entire menu of environmental statutes, with the accompanying regulations, which make up the simmering alphabet soup that federal agencies must digest to ensure compliance in the daily operation and management of their various facilities. These include the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act, as well as each of the other environmental statutes that the Environmental Protection Agency (EPA) administers and is responsible for compliance oversight and enforcement. Each contains specific provisions which require facilities of the U.S. Government to comply with environmental requirements the same as all other regulated parties. In addition, Executive Order 12088, promulgated during the Carter administration, requires that each Executive Branch agency be responsible for compliance with applicable pollution control standards which are defined in the executive order as the same substantive, procedural, and other requirements that apply to a private person. As a result, the Executive Branch and Congress have made clear their intent to waive the federal government's sovereign immunity with respect to compliance with federal environmental statutes. Given these clear-cut requirements, one might ask why continued citations appear in the press about environmental violations at various federal facilities and why there have been an increasing number of congressional oversight hearings focusing on compliance problems at federal facilities. While there are no simple answers to the continued disclosures, there are a number of contributing factors that this paper discusses, with highlights of some of the efforts being undertaken by both EPA and other federal agencies to address them. For EPA's part, it must continue to better target its inspections, enforcement, and technical assistance activities toward those federal facilities and agencies with the most significant compliance problems. It is only through EPA, the states, and the other federal agencies working together that the goal of making federal facilities the model of environmental compliance, which they truly have the obligation to become, is possible.

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### A Review of Accelerated Response Actions Available to the Environmental Restoration Program: Selected Case Histories and Associated Issues

PNL-7715; 40 pp. (May 1991)

Accelerated actions were developed by the U.S. Environmental Protection Agency (EPA) within the regulatory framework for initiating early cleanup action or accelerating ongoing cleanup action to abate, mitigate, or reduce risk to human health or the environment at a contaminated waste site. The purposes of this report are to review the regulatory frameworks available to initiate accelerated actions at sites on the National Priorities List (NPL) and to provide case histories of sites where accelerated actions have been implemented. The findings of this report are applicable to non-NPL waste sites also. Accelerated actions are of interest to the U.S. Department of Energy (DOE) for two primary reasons: (1) they are methods available to demonstrate progress in environmental restoration at DOE waste sites, and (2) a subset of accelerated actions, termed interim remedial actions, may be required in place of final actions to avoid violating National Environmental Policy Act guidelines during the development of the DOE Office of Environmental Restoration and Waste Management Programmatic Environmental Impact Statement. Accelerated actions available at DOE waste sites include removal actions performed under removal or remedial authority and interim remedial actions performed as operable units. To provide the case histories related in this report, interviews with staff and reviews of compliance documents were conducted for sites in EPA Regions II, IV, and VII. The case histories reviewed include both removal actions and remedial actions. The report indicates the advisability of a side-by-side comparison of accelerated actions and typical remedial actions to verify and quantify possible time or cost savings.

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### Chemical Exposure Evaluation in the Multimedia Environmental Pollutant Assessment System (MEPAS)

PNL-SA-18876;CONF-891053;Environmental Monitoring, Restoration and Assessment: What Have We Learned?, R.H. Gray (ed.), Proceedings of the 28th Hanford Life Sciences Symposium, Richland, WA, October 16-19, 1989, 340 pp.; (pp. 335-337) (1990)

The Multimedia Environmental Pollutant Assessment System (MEPAS) has been used by the U.S. Department of Energy (DOE) to evaluate the relative importance of remedial actions at several DOE facilities. The MEPAS analyses were reviewed to assess the value of the health-impact indicators available in MEPAS for chemical exposures. Health-impact indicators were compared for population and individual exposures and for the primary transport and exposure pathways involved. Transport pathways include groundwater, surface water, and the atmosphere.

Potential exposure pathways to off-site individuals include (1) inhalation of atmospheric pollutants; (2) ingestion of water, farm products, and aquatic foods; and (3) inadvertent ingestion resulting from dermal contact with pollutants. Individual and population health-impact indicators in MEPAS provide valuable information when evaluating the need for remedial actions of chemical waste sites.

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U.S. Congress, Office of Technology Assessment, Washington, DC

**Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production**

PB-91-143743; OTA-O-484; 223 pp. (1991)

The Senate Committee on Armed Services asked the Office of Technical Applications (OTA) to evaluate what is known about the contamination and public health problems at the Nuclear Weapons Complex and to investigate technological and other approaches to solutions. The report analyzes current and proposed methods of waste management and environmental restoration and evaluates the major DOE programs. It also discusses the prospects for improvement and describes certain initiatives that could enhance those prospects. Because the characterization of the Weapons Complex waste and contamination problem is still in the early stages, it is not possible to identify and rank specific sites that represent the most serious or immediate risks. The data are not available, and even DOE has not been able to prepare a comprehensive and credible evaluation of the situation. The focus of the OTA report is, therefore, a comprehensive look at the problem as the authors now know it, the public concerns about the problem, and DOE's plans for addressing it. It focuses especially on the need for additional attention to those areas which DOE has neither the capability nor the credibility to handle. The environmental problems at the DOE Weapons Complex are serious and complicated. Decades will be required for cleanup of certain sites while others will never be returned to pristine condition. Some sites will require much long-term monitoring and control of contaminated soil and water.

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U.S. Department of Energy, Assistant Secretary for Environment, Safety, and Health, Washington, DC

**RCRA/CERCLA Division Orientation Package**

DOE/EH-0187P; 532 pp. (May 1991)

The Environmental Reporting Requirements Handbook has been developed by U.S. Department of Energy (DOE) Headquarters' Environmental Guidance Division (EH-231) to assist DOE Field Organizations in identifying the various reporting the notification requirements that are mandated by federal environmental laws, regulations, and executive orders. The missions of the Office of Environmental Guidance are (1) to develop DOE-wide environmental policies and requirements; (2) to ensure that DOE's position is appropriately represented in the development of regulatory requirements by the U.S. Environmental Protection Agency and other federal agencies; and (3) to ensure DOE-wide understanding of DOE environmental policies, directives, laws, and regulations.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**Public Scoping Meetings on the DOE Programmatic Environmental Impact Statement**

DOE News (901106):1-3 (November 6, 1990)

This news release announces the release by the U.S. Department of Energy (DOE) of dates and locations for a series of public scoping meetings pertaining to the programmatic environmental impact statement (PEIS) on the DOE Environmental Restoration and Waste Management Program. The public is invited to comment on the PEIS, which is designed to assess potential Environmental Restoration and Waste Management Program impacts. A series of 23 public meetings will be held nationwide, beginning in December 1990. Attached to this release is the schedule for 10 meetings planned for that month.

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U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN

**Waste Reduction Workshop V**

DOE/HWP-104; CONF-9007182; Proceedings of a Waste Reduction Workshop, Idaho Falls, ID, July 24-26, 1990; (291 pp.) (September 1990)

The fifth of a series of waste minimization (WMIN)/reduction workshops (Waste Reduction Workshop V) was held at the Little Tree Inn in Idaho Falls, Idaho, on July 24-26, 1990. The workshops are held under the auspices of the U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management. The purpose of this workshop was to provide a forum for sharing site activities in WMIN/reduction planning. Topics covered were management commitment, organizational structure, goal setting, reporting requirements, data base and tracking systems, pollution prevention, awareness and incentives, information exchange, process waste assessment implementation, and recycling - internal and external. The workshops assist DOE waste-generating sites in implementing WMIN/reduction programs, plans, and activities, thus providing for optimal waste reduction within the DOE complex. All wastes are considered within this discipline: liquid, solid, and airborne, within the categories of high-level waste, transuranic waste, low-level waste, hazardous waste, and mixed waste.

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U.S. Department of Energy, Office of Energy Research, Washington, DC

**Basic Research for Environmental Restoration**

DOE/ER-0482T; 151 pp. (December 1990)

The Department of Energy (DOE) is in the midst of a major environmental restoration effort to reduce the health and environmental risks resulting from past waste management and disposal practices at DOE sites. This report describes research needs in environmental restoration and complements a previously published document, DOE/ER-0419, "Evaluation of Mid-to-Long-Term Basic Research for Environmental Restoration." Basic research needs have been grouped into five major categories patterned after those identified in DOE/ER-0419: (1) environmental transport and transformations; (2) advanced sampling, characterization, and monitoring methods; (3) new remediation technologies; (4) performance assessment; and (5) health and environmental effects. In addition to basic research, this document deals with education and training needs for environmental restoration.

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U.S. Department of Energy, Office of Environment, Safety, and Health, Washington, DC

**Environmental Audit Manual**

DOE/EH-0125 (Vol. 1); 462 pp. (January 1990)

The primary purpose of this manual is to provide a guide upon which an environmental regulatory compliance audit, assessment, or appraisal of a U.S. Department of Energy (DOE) facility can be conducted, and to ensure that all aspects of a particular regulatory area are adequately and consistently covered. In addition, this audit manual provides lines of inquiry to assess facility adherence to environmental best management practices. The protocols are in a format such that the results and observations of an audit can be documented and recorded. The ultimate objectives of the use of this manual are to document facility compliance with environmental laws and regulations, identify areas of potential noncompliance, and plan for corrective action. Although this manual has been developed by a DOE Headquarters entity, it has been designed for use at all levels within DOE.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan - Volume I**

CONF-9004181 (Vol. 1); Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp. (April 16-19, 1990)

Within the U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management, the Office of Environmental Restoration manages a number of programs for purposes of completing remedial actions at DOE facilities and sites located throughout the United States. The programs include the Surplus Facilities Management Program, the Formerly Utilized Sites Remedial Action Program, the Uranium Tailings Remedial Action Program, and the West Valley Demonstration Project. These programs involve the decontamination and decommissioning of radioactively contaminated structures and equipment, the disposal of uranium mill tailings, and the cleanup or restoration of soils and groundwater that have been contaminated with radioactive or hazardous substances. Each year the DOE and DOE contractor staff who conduct these programs meet to exchange information and experience in common technical areas. The 1990 meeting was hosted by the Uranium Mill Tailings Remedial Action Project of the DOE Albuquerque office, in that city. This volume of proceedings is part of the record of that conference. These proceedings consist of abstracts, summaries, or actual text for each presentation made and any visual aids used by the speakers. The material is organized by session in two volumes. Volume I contains: (1) Session One: Environmental Compliance - Policy; (2) Session Two: Environmental Compliance - Progress in the Field; (3) Session Three: Poster Session; (4) Session Four: Remedial Action Programs Under the Five-Year Plan; and (5) Session Five: Environmental Compliance - Concurrent Workshop Sessions. Volume II contains: (1) Session Six: Environmental Restoration Issues - Concurrent Workshop Sessions; and (2) Session Seven: Poster Session. Appendixes A and B are included in Volume II and provide the agenda and a list of the registrants.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan - Volume II**

CONF-9004181 (Vol. 2); Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 2, 276 pp. (April 16-19, 1990)

Within the U.S. Department of Energy (DOE) Office of Environmental Restoration and Waste Management, the Office of Environmental Restoration manages a number of programs for purposes of completing remedial actions at DOE facilities and sites located throughout the United States. The programs include the Surplus Facilities Management Program, the Formerly Utilized Sites Remedial Action Program, the Uranium Tailings Remedial Action Program, and the West Valley Demonstration Project. These programs involve the decontamination and decommissioning of radioactively contaminated structures and equipment, the disposal of uranium mill tailings, and the cleanup or restoration of soils and groundwater that have been contaminated with radioactive or hazardous substances. Each year the DOE and DOE contractor staff who conduct these programs meet to exchange information and experience in common technical areas. The 1990 meeting was hosted by the Uranium Mill Tailings Remedial Action Project of the DOE Albuquerque office in that city. This volume of proceedings is part of the record of that conference. These proceedings consist of abstracts, summaries, or actual text for each presentation made and any visual aids used by the speakers. The material is organized by session in two volumes. Volume I contains: (1) Session One: Environmental Compliance - Policy; (2) Session Two: Environmental Compliance - Progress in the Field; (3) Session Three: Poster Session; (4) Session Four: Remedial Action Programs Under the Five-Year Plan; and (5) Session Five: Environmental Compliance - Concurrent Workshop Sessions. Volume II contains: (1) Session Six: Environmental Restoration Issues - Concurrent Workshop Sessions; and (2) Session Seven: Poster Session. Appendixes A and B are included in Volume II and provide the agenda and a list of the registrants.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Environmental Restoration and Waste Management Robotics Technology Development Program: Robotics 5-Year Program Plan**

DOE/EM-0007T (Vol. 2); 93 pp. (1991)

This plan covers robotics research, development, demonstration, and testing activities in the U.S. Department of Energy (DOE) Environmental Restoration and Waste Management (ER&WM) Robotics Technology Development Program (RTDP) for the next five years. These activities range from bench-scale research and development to full-scale hot demonstrations at DOE sites. This plan outlines applications of existing technology to near-term needs, the development and application of enhanced technology for longer-term needs, and an initiation of advanced technology development to meet those needs beyond the 5-year plan. The objective of RTDP is to develop and apply robotics technologies that will enable ER&WM operations at DOE sites to be safer, faster and cheaper. Five priority DOE sites were visited in March 1990 to identify needs for robotics technology in ER&WM operations. This 5-year program plan for RTDP detailed annual plans for robotics technology development based on identified needs. This 5-Year program plan discusses the overall approach to be adopted by the RTDP to aggressively develop robotics technology and contains discussions of the Program Management Plan, Site Visit and Needs Summary, Approach to Needs-Directed Technical Development, Application-Specific Technical Development, and Cross-Cutting and Advanced Technology. Integrating application-specific ER&WM needs, the current state of robotics technology, and the potential benefits of new technology (in terms of faster, safer, and cheaper machines), the plan develops application-specific road maps for Robotics Research, Development, Demonstration, Testing and Evaluation Program for the period FY 1991 through FY 1995. In addition, the plan identifies areas where longer-term research in robotics will have a high payoff in the 5- to 20-year time frame.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC

**Merit Review System - Office of Environmental Restoration and Waste Management**

Federal Register 56(87):20602-20603 (May 6, 1991)

The Office of Environmental Restoration and Waste Management (EM) is publishing its Merit Review System in accordance with requirements set forth in the U.S. Department of Energy Financial Assistance Rules (10 CFR 600). This notice establishes the procedures to be followed by EM program offices in conducting the merit review of discretionary financial assistance applications submitted pursuant to 10 CFR 600. This notice sets forth the EM Merit Review System as follows: (1) purpose and scope, (2) responsible official, (3) deviations, and (4) evaluation process. The EM policies and procedures set forth in this notice are applicable to the following program areas: (a) technology development for waste management and environmental restoration; (b) environmental educational development; (c) technology integration and transfer; (d) applied research and development; (e) demonstration, testing, and evaluation; (f) waste minimization, treatment, and disposal; (g) monitoring equipment, facilities, and technologies; (h) characterization; (i) laboratory testing and measurement; (j) remediation technology, including in situ treatment; (k) transportation and packaging of radioactive, mixed, and other hazardous materials/wastes; and (l) related systems or activities to enhance the infrastructure supporting these areas.

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U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Washington, DC; Virginia Polytechnic Institute and State University, Management Systems Laboratories, Blacksburg, VA

**Environmental Restoration and Waste Management (EM) Program: An Introduction**

DOE/EM-0005P; 91 pp. (December 1990)

This booklet introduces the reader to the mission and functions of a major new unit within the U.S. Department of Energy (DOE): the Office of Environmental Restoration and Waste Management (EM). The Secretary of Energy established EM in November 1989, implementing a central purpose of the DOE first annual Environmental Restoration and Waste Management Five-Year Plan, which had appeared 3 months earlier. The contents of this booklet and their arrangement reflect the annual update of the Five-Year Plan. The Five-Year Plan supports DOE's strategy for meeting its 30-year compliance and cleanup goal. This strategy involves focusing DOE's activities on eliminating or reducing potential risks to worker and public health and the environment; containing or isolating, removing, or detoxifying on-site and off-site contamination; and developing technology to achieve DOE's environmental goals.

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U.S. Department of Energy, Washington, DC

**Waste Management and Environmental Restoration**

CONF-9010166; Proceedings of the 1990 DOE Model Conference, Oak Ridge, TN, October 29-November 2, 1990, 343 pp. (1990)

Reports dealing with current topics in waste management and environmental restoration were presented at this conference in 6 sessions. Session 1 covered the "Hot Topics," including regulations and risk assessment. Session 2 dealt with waste reduction and minimization; Session 3 dealt with waste treatment and disposal. Session 4 covered site characterization and analysis. Environmental restoration and associated technologies were discussed in Sessions 5 and 6. Individual papers will be catalogued separately in Volume 13 of this bibliography.

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U.S. Department of Energy, Washington, DC

**Environmental Restoration and Waste Management: Five-Year Plan Executive Summary - Fiscal Years 1992-1996**

DOE/S-0077P; 63 pp. (June 1990)

This document reaffirms the U.S. Department of Energy's (DOE's) commitment to a 30-year goal of compliance with laws, regulations, and agreements aimed at protecting human health and the environment; consolidates DOE's planning for Environmental Restoration, Waste Operations (including Corrective Activities), and Technology Development (including Transportation and Education); reports progress made toward achieving compliance goals; and explains changes in strategy resulting from new policies and external events.

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U.S. Department of Energy, Washington, DC

**Environmental Restoration and Waste Management: Five-Year Plan - Fiscal Years 1993-1997**

DOE/S-0089P; 783 pp. (August 1991)

In the first Five-Year Plan (Plan), written in 1989, the Department of Energy (DOE) committed to rapidly bring all operating facilities into compliance with applicable laws and regulations and to clean up the 1989 inventory of contaminated inactive sites and facilities by the year 2019. This Fiscal Year 1993-1997 Five-Year Plan moves the Office of Environmental Restoration and Waste Management (EM) one step closer to this 30-year goal. The overall EM strategy has three thrusts. First, where risk assessment shows an actual or potential threat to human health and safety, then immediately do whatever is possible to reduce, mitigate, stabilize, and confine the threat. Second, where nobody knows how to solve a problem (as distinguished from merely preventing it from getting worse), then act decisively to develop methods to do it right the first time. Third, where compliance and cleanup must proceed with or without next-generation technologies, then plan (with affected parties and within the provisions of Interagency Agreements) the work to be accomplished and its schedule. This third Five-Year Plan discusses current EM program accomplishments, what the program intends to do over the next 5 years, and the direction the program must take in order to meet its 30-year and other environmental goals. The Plan is founded on data from all across the DOE system. The document is divided into the following main topics: (1) EM strategic plan, (2) EM planning process, (3) corrective activities, (4) waste management, (5) environmental restoration, (6) technology development, (7) transportation activities (8) installation summaries, and (9) appendices.

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U.S. Department of Energy, Washington, DC

**Environmental Restoration and Waste Management: Five-Year Plan Executive Summary - Fiscal Years 1993-1997**

DOE/S-0090P; 18 pp. (August 1991)

The U.S. Department of Energy's Office of Environmental Restoration and Waste Management (EM) recognizes that cleaning up the Nation's nuclear-related sites and facilities will impact many different segments of the public, ranging from the communities surrounding these sites and facilities to the research laboratories developing new technologies to assist in the cleanup. To assist the public in understanding the EM program, the complete EM Five-Year Plan for Fiscal Years 1993-1997 (Plan) has been prepared. Section 1 of the Plan describes the EM strategic plan and the EM planning process. Section 2 presents the Five-Year Program Plans for corrective activities, waste management, environmental restoration, technology development, and transportation. Section 3 includes 37 installation summaries that provide synopses of past, present, and future activities at each major installation, technology summaries on the key application areas, and transportation activities. The appendices include information on installations, agreements, comments, and prior commitments.

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U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, DC

**Radioactivity-Contaminated Sites**

PB-90-227950; EPA/520/1-90/009; Proceedings of an EPA Workshop, Albuquerque, New Mexico, May 3-5, 1989, 181 pp. (March 1990)

The report is a compilation of reports presented at a workshop that was sponsored jointly by the U.S. Environmental Protection Agency (EPA) Office of Radiation Programs and Office of Emergency and Remedial Response. They include status reports from the U.S. Department of Energy, the Department of Defense, private industry, EPA case studies, and summaries of applicable technology and research.

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U.S. General Accounting Office, Washington, DC

**Nuclear Health and Safety: Status of GAO's Environmental, Safety, and Health Recommendations to DOE**

GAO/RCED-90-125; 16 pp. (1990)

In a federal government report, the General Accounting Office (GAO) has called attention to the mounting health recommendations to the U.S. Department of Energy (DOE) and problems facing DOE's nuclear weapons complexes since 1980. Serious and costly environmental, safety, and health problems at these facilities have been identified. GAO has called for independent oversight of DOE nuclear operations and has recommended that the agency strengthen its own oversight and provide more detailed information to Congress, while improving its management and accounting practices. Of the 54 recommendations made by GAO, DOE has yet to address or comply with 23 of them. These open recommendations call for tighter programs and clearer standards related to environmental, safety, and health matters.

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U.S. Nuclear Regulatory Commission, Washington, DC

**Compilation of Reports of the Advisory Committee on Nuclear Waste - July 1988-June 1990**

NUREG-1423-V1; 111 pp. (August 1990)

The compilation contains 37 reports issued by the Advisory Committee on Nuclear Waste during the first two years of its operation. Topics include the Nuclear Regulatory Commission (NRC) analysis of the U.S. Department of Energy Site Characterization Plan for the high-level radioactive waste repository, the standards promulgated by the U.S. Environmental Protection Agency for the disposal of high-level waste, the NRC policy statement on Below Regulatory Concern, technical documents prepared by the NRC staff relative to the decommissioning of nuclear power plants, the stabilization of uranium mill tailings piles, and environmental monitoring.

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United States Government Printing Office, Superintendent of Documents, Washington, DC

**Funding for Cleanup of Energy Waste Should Not Be Reduced**

Congressional Record 137(106):H5399 (July 11, 1991)

Congressman Luken urged the U.S. House of Representatives to resist attempts to reduce funding for the Department of Energy's cleanup efforts, citing reports that the Department's budget will be amended to significantly reduce the amount of money earmarked by the House for remediation of contaminated federal facilities.

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United States Government Printing Office, Superintendent of Documents, Washington, DC

**Federal Facilities Compliance Act**

Congressional Record 137(66):H2767 (May 2, 1991)

The Federal Facilities Compliance Act of 1991 subjects federal facilities to the same enforcement sanctions and penalties as private operations that generate hazardous wastes. Several members of the House publicly expressed their support for the Act, including Congressmen Biley, Eckart, Schaefer, Gephardt, Bilbray, Hefley, Klug, and others. The lawmakers commented that because of the magnitude and types of wastes generated at federal facilities, federal operators should be made to comply with applicable environmental regulations to the same extent as other polluters.

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Westinghouse Materials Company of Ohio, Cincinnati, OH

**FMPC Environmental Restoration and Waste Management Site Specific Plan**

FMPC-2214; 119 pp. (July 1990)

The Feed Materials Production Center (FMPC) is located in southwestern Ohio, approximately 20 miles northwest of downtown Cincinnati near the communities of Miamitown and Ross, Ohio. FMPC is owned by the U.S. Department of Energy (DOE), managed by the Oak Ridge Operations Office, and operated by the Westinghouse Materials Company of Ohio (WMCO). The FMPC was built by the U.S. Atomic Energy Commission to establish an in-house integrated production complex for processing uranium and its compounds from natural uranium ore concentrates. A wide variety of chemical and metallurgical process steps are utilized to support the manufacturing of uranium metal products that began in 1953. Site modifications since then have not resulted in significant expansion of the approximately 300 acres originally established for production and waste management purposes. One of the functions of FMPC has been to produce purified depleted uranium metal for use at the Oak Ridge Y-12 Plant and the Rocky Flats Site. The feedstock for uranium metal production comes primarily from uranium tetrafluoride obtained from inventory and uranium hexafluoride from the gaseous diffusion plants. This paper discusses waste management and environmental restoration at FMPC.

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**Remedial Action Assessment System (RAAS):**

**A Computer-Based Methodology for Conducting Feasibility Studies**

PNL-SA-19002; CONF-910270; Waste Management '91: Working Towards a Cleaner Environment - High-Level Waste, Low-Level Waste, Mixed Waste and Environmental Restoration, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 24-28, 1991; (16 pp.); PNL-SA-18882; CONF-910287; Control of Hazardous Materials, Proceedings of the National Research and Development Conference, Anaheim, CA, February 20-22, 1991; (17 pp.) (February 1991)

Because of the complexity and number of potential waste sites facing the U.S. Department of Energy (DOE) for potential cleanup, DOE is supporting the development of a computer-based methodology to streamline the remedial investigation/feasibility study process. The Remedial Action Assessment System (RAAS), can be used for screening, linking, and evaluating established technology processes in support of conducting feasibility studies. It is also intended to do the same in support of corrective measures studies. The user interface employs menus, windows, help features, and graphical information while RAAS is in operation. Object-oriented programming is used to link unit processes into sets of compatible processes that form appropriate remedial alternatives. Once the remedial alternatives are formed, the RAAS methodology can evaluate them in terms of effectiveness, implementability, and cost. RAAS will access a user-selected risk assessment code to determine the reduction of risk after remedial action by each recommended alternative. The methodology will also help determine the implementability of the remedial alternatives at a site and access cost-estimating tools to provide estimates of capital, operating, and maintenance costs. This paper presents the characteristics of two RAAS prototypes currently being developed. These include the RAAS Technology Information System, which accesses graphical, tabular and textual information about technologies, and the main RAAS methodology, which screens, links, and evaluates remedial technologies.

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**The Department of Energy Environmental Restoration Program: Meeting the Challenges**

CONF-900210 (Vol. 1); Waste Management '90: Working Towards a Cleaner Environment - Waste Processing, Transportation, Storage and Disposal, Technical Programs and Public Education - Overview and General Waste Management, R.G. Post (ed.), Proceedings of a Conference, Tucson, AZ, February 25-March 1, 1990, Vol. 1, 813 pp.; (pp. 77-82) (1990)

In August 1989, U.S. Department of Energy (DOE) Secretary James D. Watkins provided the United States Congress with DOE's first annual Environmental Restoration and Waste Management (ER&WM) Five-Year Plan. In this document, DOE committed to the goal of assessment and cleanup, within 30 years, of inactive facilities and sites contaminated by wastes generated from past DOE nuclear operations. To accomplish this goal, an integrated Environmental Restoration Program has been established which consists of two fundamental sets of activities: remedial actions at inactive waste sites, and the decontamination and decommissioning of surplus facilities. This paper summarizes the DOE Environmental Restoration Program, discusses the major environmental restoration challenges in the ER&WM Five-Year Plan, and provides a summary of recent activities initiated by DOE to meet those challenges.

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C. Yu, Argonne National Laboratory, Argonne, IL

**Cleanup Criteria and Dose Calculations Using RESRAD**

CONF-9004181 (Vol. 1); Remedial Action Under the Environmental Restoration and Waste Management Five-Year Plan, Proceedings of the Department of Energy Remedial Action Program Conference, Albuquerque, NM, April 16-19, 1990, Vol. 1, 656 pp.; (pp. 257-280) (April 1990)

RESRAD is a computer code developed at Argonne National Laboratory for the U.S. Department of Energy. It is designed to calculate site-specific RESidual RADioactive (RESRAD) material guidelines and radiation doses to the on-site resident (maximally exposed individual). A guideline is a radionuclide concentration or level of radioactivity that is acceptable if a site is to be used without radiological restrictions. Guidelines are expressed as (1) concentrations of residual radionuclides in soil, (2) concentrations of airborn radon decay products, (3) levels of external gamma radiation, (4) levels of radioactivity from surface contamination, and (5) concentrations of residual radionuclides in air and water. Soil is unconsolidated earth material, including rubble and debris, which may be present. The guidelines are based on the following principles: (a) the annual radiation dose received by a member of the critical population group from the residual radioactive material - predicted by a realistic but reasonably conservative analysis and averaged over a 50-year period - should not exceed 100 mrem/yr and (b) doses should be kept as low as reasonably achievable (ALARA). Seven environmental pathways are considered: direct exposure; inhalation; and ingestion of foods, meat, milk, aquatic foods, and water. The RESRAD code runs on an IBM or IBM-compatible personal computer with a hard drive and least 400 kilobytes of memory. Installation is simple, in part because of self-extracting files. It is user-friendly, incorporating internal interactive help files and information on input and output data. The main menu presents all accessible inputs and outputs and the major data and function categories. RESRAD uses a pathway analysis method in which the relationship between radionuclide concentrations in the dose to a member of the critical population group is expressed as a pathway sum, which is the sum of the products of pathway factors. Pathway factors correspond to pathway segments connecting compartments in the environment among which radionuclides can be transported or radiation transmitted. This presentation includes 20 viewgraphs on the RESRAD code.

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