2F

PNL-4637
UC-70

International Fuel Cycle and Waste Management Technology Exchange Activities Sponsored by the United States Department of Energy— FY 1982 Evaluation Report

L. T. Lakey
K. M. Harmon

February 1983

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-4637

DISCLAIMER

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

NTIS Price Codes
Microfiche A01

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

PNL-4637
UC-70

INTERNATIONAL FUEL CYCLE AND WASTE MANAGEMENT TECHNOLOGY EXCHANGE ACTIVITIES SPONSORED BY THE UNITED STATES DEPARTMENT OF ENERGY-- FY 1982 EVALUATION REPORT

L. T. Lakey
K. M. Harmon

February 1983

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

CONTENTS

SUMMARY

As national policy, the US Department of Energy supports technology exchange with selected countries on non-defense-related nuclear programs. This exchange includes participation in the work and meetings of international agencies such as OECD and IAEA, exchange of professional personnel on visits to and from other countries, and joint R&D programs (e.g., the Stripa Mine in situ testing program in Sweden). Agreements defining the extent and areas of exchange in the fuel reprocessing and waste management areas have been signed with Belgium, Canada, Federal Republic of Germany, Japan, Sweden, and the United Kingdom; others are being negotiated.

In FY 1982, DOE and DOE contractor personnel attended 40 international symposia and conferences on fuel reprocessing and waste management subjects. Visitors from abroad exceeded US visitors to other countries. Records indicate that about 233 foreigners visited the US and about 127 US personnel visited other countries. The largest exchanges occurred with the Federal Republic of Germany (123), France (31), Japan (100), Sweden (26), and the United Kingdom (32). In these cases, the ratio of US visitors to foreign sites over foreign visitors to US sites was higher in two instances--Sweden (16/10) and the United Kingdom (20/12). In the others, the ratio was reversed--Japan (24/76, France (15/16), and FRG (32/91). Generally, the exchange benefits the visitor more than the host. Over 80% of the visits were made with countries covered by an exchange agreement. However, only about 20% planned visits as part of an exchange agreement.

The treatment of high-level waste was the topic most often covered in the visits, with geologic disposal and general waste management also being covered in numerous visits. Topics discussed less frequently include TRU/LLW treatment, airborne waste treatment, D&D, spent fuel handling, and transportation.

The benefits accruing to the US from technology exchange activities with other countries are both tangible, e.g., design of equipment, and intangible, e.g., improved foreign relations. New concepts initiated in other countries, particularly those with sizable nuclear programs, are beginning to appear in US

efforts in growing numbers. The spent fuel dry storage concept originating in the FRG is being considered at numerous sites. Similarly, the German handling and draining concepts for the joule-heated ceramic melter used to vitrify wastes are being incorporated in US designs. Other foreign technologies applicable in the US include the slagging incinerator (Belgium), the SYNROC waste form (Australia), the decontamination experience gained in decommissioning the Eurochemic reprocessing plant (Belgium), the engineered surface storage of low- and intermediate-level waste (Belgium, FRG, France), the air-cooled storage of vitrified high-level waste (France, UK), waste packaging (Canada, FRG, Sweden), disposal in salt (FRG), disposal in granite (Canada, Sweden), and sea dumping (UK, Belgium, The Netherlands, Switzerland). These technologies did not necessarily originate within foreign countries; many originated or have been tried in the US but for various reasons are now being applied and extended in other countries. This growing nuclear technological base in other countries reduces the number of technology avenues the US need follow to develop a solid nuclear power program.

Most of the US DOE/foreign country exchanges involve fairly sophisticated technology with those countries (FRG, France, Japan, UK) having well advanced nuclear fuel cycle activities. Technology exchange with the less developed countries occurs primarily through participation in the activities (seminars, symposia) of the international organizations. The most active exchanges are associated (from the US DOE side) with the funded mission-oriented activities such as the CFRP, ONI, and TWSO programs. This is understandable as such programs have specific technology needs which can be met through such exchanges.

INTRODUCTION

A significant feature of United States nuclear fuel cycle and waste management policy is the continuing national commitment to participate in cooperative international R&D programs. In pursuit of this commitment the US Department of Energy:

- Sponsors active participation by DOE and DOE contractor personnel in the work of the major international nuclear agencies such as IAEA and OECD-NEA. These efforts allow information exchanges with many countries, including nations with which the US has no bilateral arrangements for information exchange.
- Is significantly increasing the level of US effort to implement the formal agreements with Belgium, Canada, Federal Republic of Germany, Japan, Sweden, the United Kingdom, and the Commission of European Communities (CEC) to exchange technology and engage in other cooperative activities. A similar agreement is being negotiated with France.
- Encourages DOE contractors to host visitors from non-agreement nations at DOE sites and exchange technical information.
- Sponsors participation in a variety of international symposia and bilateral information exchanges, some in considerable technical depth.
- Sponsors US cooperation in joint experimental programs (e.g., the NEA-coordinated multinational R&D program at the Stripa Mine in Sweden).

The advantages of devoting US technical and financial resources to international cooperation on nuclear fuel cycle and waste management R&D may be summarized as follows.

- Public confidence in the US and other countries is enhanced by international agreement on the soundness of the technology underlying fuel cycle and waste management systems.

- International concurrence in criteria, standards, guidelines and test methods is highly important to all nuclear countries and can be attained only through cooperation.
- Certain nuclear fuel cycle and waste management problems may prove to have solutions which require international activities and agreements, e.g., atmospheric pollution, transportation of spent fuels and waste across national borders or the oceans, use of the oceans or subseabed formations for waste disposal, or multinational regional disposal.
- "Cross investment" of R&D resources in complex areas of technology minimizes the incentives for every country to investigate all potentially favorable solutions to a given problem and thus should hasten development of satisfactory systems. This is particularly desirable in geologic waste disposal because of the variety of geologic formations in various countries.
- The exchanges provide scientists a better overview of the fields investigated, and thus reduce provincialism and help establish personal contacts and channels for acquiring information.
- Less tangible, but no less important, benefits of international technology exchanges include the promotion of higher living standards (particularly in underdeveloped countries), the promotion of communication and mutual understanding between countries, and the promotion of commercial trade.

This document, covering FY 1982, is based on material made available by DOE contractors and operations offices to PNL's International Program Support Office. It summarizes US DOE participation in the meetings sponsored by the international agencies, international information exchanges (INFX) carried out under existing bilateral agreements, and visits to or from non-agreement countries on fuel cycle and waste management business. It also attempts to provide a summary of benefits of these technology exchanges.

BILATERAL EXCHANGE ACTIVITIES

Cooperative waste management activities sponsored by DOE are reported in this section. Appendix A provides: 1) a log of specific information exchanges occurring between October 1, 1980 and September 30, 1981, 2) a log detailing US DOE attendence at symposia and seminars sponsored by the major international agencies, and 3) a log detailing US DOE contributions to studies by the NEA, IAEA, and agencies as consultants, technical experts, and members of workshops.

AUSTRALIA

Fuel Cycle Programs and Plans

1. Uranium mining and milling (1981 production was 2600 Mg).
2. Planning UF_6 production.
3. Negotiating with Urenco for gas centrifuge enrichment technology.
4. Completion of first nuclear power station, tentatively scheduled for 1995 and to be located near Perth in western Australia.
5. R&D under way on mill tailings management.
6. Developing SYNROC process to demonstrate HLW immobilization. Form has been patented, and an engineering-scale demonstration is planned.

US DOE/Australian Cooperation

1. A bilateral arrangement in radioactive waste management was proposed in 1979, but negotiations were never completed. The proposed scope included information, sample and personnel exchange, and hot cell tests by a US DOE laboratory in support of the AAEC's SYNROC process development program.
2. Evaluation of the SYNROC process at Lawrence Livermore National Laboratory was discontinued at the end of FY 1982 with a decision by DOE to use borosilicate glass for the immobilization of SRP HLW.

3. PNL and AAEC researchers are continuing radiation damage studies using samples of SYNROC produced at both sites.

4. Information exchanges during FY 1982 included two visits to US sites by Australian personnel. A. T. Duff of the AAEC Lucas Heights Research Laboratories visited ANL and ORNL in June 1982 to obtain an overview of laboratory waste management practices. Professor R. Segall of Griffith University visited LANL, LLNL, ORNL, and SNL in September 1982 to discuss characterization of crystalline (SYNROC) and other waste forms.

AUSTRIA

Fuel Cycle Programs and Plans

1. No domestic uranium supply.
2. LWR capacity is 0.73 GWe (Tullnerfeld BWR power station was built but not commissioned because of legal constraints).
3. Foreign fuel reprocessing if Tullnerfeld is ever allowed to start up.
4. Limited R&D on treatment and storage of HLW and non-HLW and on geologic waste isolation.

US DOE/Austrian Cooperation

1. Limited information exchange is occurring. There is little or no incentive to the US for a formal US DOE/Austria agreement.
2. No exchange of visits occurred in FY 1982.

BELGIUM

Fuel Cycle Programs and Plans

1. No domestic uranium supply; participant in Eurodif (11%) and Coredif (5.7%) enrichment projects; fabrication of LWR and MOX fuels.
2. LWR capacity: 1.67 GWe (1982), 5.5 GWe (1990).

3. Fuel reprocessing in former Eurochemic plant, plutonium recycle, vitrification of HLW.

4. R&D on reactor development (LWR and FBR), fuel reprocessing, waste treatment and storage.

5. Waste disposal in a clay repository, probably at Mol; R&D in an underground test facility (HADES) at Mol.

Bilateral Agreement

Status

Effective January 19, 1981 to January 19, 1985.

Participants

Centre d'Étude de l'Énergie Nucléaire (CEN/SCK) and US DOE.

Technical Scope

Exchange of personnel, information, samples, materials, instruments and components as part of cooperative research; organization of seminars and meetings on terminal storage in geologic formations, technology of retrievable storage, waste processing technology and environmental effects; reciprocal visits to R&D centers.

Program Status

Belgium has proposed DOE participation in studies of an in situ clay repository at Mol, but DOE/ONWI is not presently interested. Belgium has also expressed an interest in exchanges on solid waste treatment and quality control and has suggested two exchange visits to the US in 1982 on these topics. These were not made.

CEN/SCK was under contract in FY 1981 with EG&G-Idaho to test the incineration of INEL TRU wastes in the slagging incinerator (FLK 60) at Mol. The test program was discontinued early in 1982 as the Mol unit lacked the capability to process EG&G type wastes. The Belgian incinerator has been operating on low β-γ wastes.

Information exchanges in FY 1982 included four exchange visits by DOE and DOE contractor personnel to Eurochemic and to CEN/SCK on waste management topics. A. Bonne of CEN/SCK visited PNL and RHO in March 1982 to discuss geologic disposal.

BRAZIL

Fuel Cycle Programs and Plans

1. Uranium production (550 Mg/yr in 1982); UF_6 conversion capability planned for 1985.
2. LWR capacity: 0.62 GWe (1980), 3.1 GWe (1987).
3. Rely heavily on foreign technical assistance for LWR power plants (FRG), conversion (France), enrichment (FRG), reprocessing (FRG), and fast reactors (Italy).
4. Four research and development sites.

US DOE/Brazil Cooperation

No specific cooperative activities, including visits, occurred in FY 1982.

CANADA

Fuel Cycle Programs and Plans

1. Uranium mining and milling (8400 Mg in 1981), conversion, PHWR fuel fabrication.
2. PHWR (CANDU) capacity: 5.5 GWe (1981), 10.3 GWe (1985), 14.5 GWe (1990); development of a thorium-fueled CANDU reactor system.
3. Potentially, reprocessing of CANDU (uranium and thorium) spent fuels, with recycle of Pu or ^{233}U and immobilization of HLW.
4. Waste treatment and storage.

5. Storage of spent fuel and/or disposal of immobilized HLW in a geologic repository, probably in granite; storage of ILW and LLW in engineered surface structures.

Bilateral Agreement

Status

Effective September 8, 1976 to September 8, 1980; extended until September 8, 1981; and renewed for five years effective August 25, 1982.

Participants

Atomic Energy of Canada, Limited (AECL) and US DOE.

Technical Scope

Exchange of information, personnel, samples, materials, and equipment as part of cooperative research; reciprocal visits to nuclear centers; organization of seminars and workshops on mutually agreeable topics; and participation in cooperative R&D projects. The fields of cooperation include:

1. Preparation and packaging of radioactive wastes
2. Decontamination and decommissioning
3. Surface and subsurface storage
4. Characterization of geologic formations
5. Disposal in geologic formations
6. Transportation requirements
7. Operational considerations
8. Environmental and safety considerations
9. Public acceptance issues.

Program Status

Two US DOE/Canadian meetings were held in early FY 1979 to identify specific areas of cooperation in the field of waste isolation, including field test experiments, field measurement techniques, heater test designs, backfill and sealing development, drilling and mining techniques, repository performance assessment, engineered barrier systems studies, geohydrologic studies, and ion migration studies. In a follow-up meeting in October 1980, DOE and ONWI

representatives agreed to US technical and financial participation in the AECL project to build and operate an in situ test facility, the Underground Research Laboratory (URL), near Whiteshell.

Exchange visits and further discussions on cooperation on the URL program continued through FY 1981 and FY 1982. The US DOE, through ONI, budgeted $500,000 for activities in support of the URL. In FY 1982, these activities included provision of a technical consultant to Canada and assistance by LLNL on thermal response calculations, and by CSM on excavation technology.

Exchange visits in FY 1982 included W. F. Ubbes' (ONWI) participation in the URL Project Management Committee Meeting at Whiteshell in October 1981 and the Canada/DOE review of the waste management agreement at Columbus, Ohio, in January 1982.

CHINA (PEOPLE'S REPUBLIC)

Fuel Cycle Programs and Plans

1. Current nuclear program is well developed on a small scale for weapons production. It includes uranium conversion, enrichment by gaseous diffusion, fuel fabrication, reprocessing, and waste treatment.
2. Nuclear power is projected at 2.1 GWe (1990) and 8.1 GWe (2000).

US DOE/China Cooperation

1. Very little exchange has occurred.
2. In March 1982, Dr. G. Guoying, Associate Professor at China's Academia Senica in Shanghai, visited RHO to discuss BWIP and analytical instrumentation (measurement of inorganic elements by inductively coupled plasma spectroscopy and impurities in uranium and plutonium). Five representatives of the People's Republic of China visited several US sites (ORNL, DOE-Hq, BNL, West Valley, PNL, Bechtel-SF) in May 1982 to learn about low-level radioactive waste disposal activities in the US.

DENMARK

Fuel Cycle Programs and Plans

1. Parliament has not yet decided to permit introduction of nuclear power, but is sponsoring limited R&D on waste treatment and waste isolation.

2. The two Danish utilities, Elsam and Elkraft, investigated the possibilities of disposing of radioactive waste in salt domes in Northern Jutland. The work was carried out in two phases: initial investigations based on the geological knowledge then available were carried out from 1977 to 1978 (Phase 1). From then and until the beginning of 1981, extensive geologic investigations, including materials testing, were carried out (Phase 2). The reports on these investigations are now being reviewed by a judgment committee of members assigned from Danish agencies having regulating authority.

US DOE/Danish Cooperation

Limited information exchange is occurring; there is little or no US incentive for a formal US DOE/Denmark agreement. M. Kehnemuyi (ONI) attended the Symposium on the Result of Geologic Investigations for High-Level Waste Disposal in the MORS Salt Dome held in Copenhagan, November 1981.

FEDERAL REPUBLIC OF GERMANY

Fuel Cycle Programs and Plans

1. Small (35 MgU in 1980) domestic production of uranium.

2. LWR capacity: 9.7 GWe (1981), 19.6 GWe (1985); LMFBR capacity: 0.3 GWe (1985); THTR capacity: 0.3 GWe (1982).

3. Fuel fabrication, enrichment, fuel reprocessing, plutonium recycle, vitrification of HLW.

4. Dry interim storage of spent fuel.

5. Salt dome repository for HLW, non-HLW, and (potentially) spent fuels. Study scheduled for completion will define a reference disposal concept--encapsulation technique, canister, and emplacement method.

6. Iron mine repository (KONRAD) for non-alpha LLW and ILW. Licensing procedure started in 1982.

Bilateral Agreement

Status

Effective December 20, 1974, for a 5-year period; extended to December 31, 1984, by an amendment dated March 19, 1980.

Participants

FRG Bundesministerium für Forschung und Technologie (FRG/BMFT) and US DOE.

Technical Scope

Exchange of technical reports, experimental data, and visits. Arrangement of joint meetings of experts. Execution of joint programs and projects. The technical areas of cooperation include:

1. Preparation of waste forms
2. Decontamination and decommissioning
3. Surface storage
4. Characterization of geologic formations
5. Disposal in geologic formations
6. Transportation requirements
7. Operational considerations
8. Environmental and safety considerations
9. Public acceptance issues.

Program Status

The US DOE/FRG exchange of technology was active in FY 1982 and included numerous staff visits to nuclear facilities, extended assignments, cooperative R&D at the Asse Salt Mine, and planning meetings.

In FY 1982, the exchange included visits of 91 FRG personnel to US sites and 32 US personnel to FRG sites. The visitors from FRG were predominantly engineering-oriented, with interests in HLW treatment and facility design. The interests of US visitors to FRG were divided evenly among HLW treatment, other waste treatment, and geologic isolation. The high interest of the FRG in HLW treatment and facilities is a result of the active FRG projects of installing HLW waste treatment facilities at Karlsruhe (HOVA) and Mol, Belgium (Pamela).

Five personnel had extended assignments in FY 1982. B. Grambow of HMI completed an extended assignment at PNL in May 1982, where he was engaged in HLW form characterization studies. J. Krekeler of GSF/IfT worked at ONWI, SNL, and RE/SPEC on waste isolation studies over the period November 1981 through March 1982. H.-P.Wichmann of KfK was assigned to ENICO for three weeks ending May 1982, to participate in studies on offgas treatment. R. R. Hammer of ENICO spent seven weeks at KfK during September-November 1981, to participate in R&D on krypton recovery and purification. T. J. Headley of SNL spent six weeks at HMI ending in June 1982 on materials characterization research. Five US scientists visited Karlsruhe and Mol, Belgium, in September 1982 for a US DOE/FRG meeting of HLW vitrification specialists.

Development of a program to exchange information about geologic waste isolation, initiated in the fall of 1979, resulted in an addendum to the primary agreement on cooperation in brine migration experiments at the Asse Salt Mine. Under this agreement, effective for five years beginning October 1, 1981, the US will provide test equipment and design assistance while FRG will build and operate the experiments. By the end of the reporting year, the experimental installations were well under way. Testing is scheduled to begin early in CY 1983.

FINLAND

Fuel Cycle Programs and Plans

1. No uranium production, fuel fabrication, or uranium enrichment.
2. LWR capacity: 2.2 GWe (1981), additional power stations under consideration.

3. Foreign reprocessing of spent fuels.
4. Limited R&D on treatment of non-HLW.
5. Studies of the use of Finnish crystalline rock formations for waste disposal.

US DOE/Finnish Cooperation

Limited information exchange is occurring. There is little or no US incentive for a formal agreement.

FRANCE

Fuel Cycle Programs and Plans

1. Estimated uranium production of 2824 tonnes in 1981.
2. Nuclear power production: 12 GWe (1980), 35 GWe (1985), 54 GWe (1990)--including 4-6 GWe from LMFBR.
3. Fuel fabrication, enrichment, reprocessing of foreign and domestic spent fuels, recycle of plutonium, vitrification and interim surface storage of HLW.
4. Development of a repository (salt or crystalline rock) for long-lived wastes ($t_{1/2} > 30$ years).

Bilateral Agreement

A bilateral agreement for information exchange in waste management was proposed to the Commissariat a l'Énergie Atomique (CEA) by US/ERDA in 1975, but negotiations were never completed. During FY 1981, CEA representatives proposed that a bilateral meeting be held to discuss US and France radionuclide migration and hydrologic transport field tests. The proposed meeting was held October 22-23, 1981, in Paris, where it was agreed that further information exchange was desirable in the waste isolation area. Subsequently, J. Lefevre, N. Sugier, and P. Jourde of CEA visited DOE-Headquarters in March 1982 to start formal negotiations toward an official bilateral cooperative agreement between the French CEA and US DOE in the area of waste management technology. In July

1982, the French CEA submitted a draft agreement for consideration by DOE covering the following fields of cooperation:

- Preparation and packaging of radioactive wastes
- Decontamination and decommissioning
- Surface and subsurface storage
- Characterization of geologic formations
- Disposal in geologic formations
- Transportation requirements.

The proposed exchange agreement was discussed further at a US DOE/France bilateral meeting held August 27, 1982 at DOE Headquarters. At this time, it was agreed to limit the exchange to waste treatment R&D, extending to pilot plant stage but not including the testing of full-scale prototypes. Operating experience in French industrial plants is considered proprietary. The US DOE is now rewriting the draft agreement for further consideration by the French CEA.

US DOE/French Cooperation

1. US DOE/France information exchanges occur principally through joint participation in international committee meetings, conferences, and workshops. Additional exchanges in the form of survey visits to US and French sites are increasing.

2. Cooperative activities during FY 1982 included eight visits to French sites by scientists from DOE, ANL, PNL, ONWI, HEDL, LLNL, LANL, and Harvard University to discuss waste treatment and handling, hydrology, radionuclide migration, ocean disposal, and geologic disposal. Six French teams visited DOE-Hq, PNL, SNL, ORNL, LLNL, LANL, ONWI, ANL, RHO, and TMI to discuss waste treatment and disposal.

3. France has declined to engage in technology exchange in the area of spent fuel reprocessing because of the commercial nature of their reprocessing activities.

4. DOE-Hq (D. J. McGoff) and the French CEA are developing a subagreement to the principal waste management exchange agreement. The subagreement will cover cooperation on TMI waste management activities.

INDIA

Fuel Cycle Programs and Plans

1. Limited uranium mining and milling (200 tonnes/yr).
2. PHWR-LWR capacity: 0.86 GWe (1981), 1.33 GWe (1985), 5 GWe (1990); conversion to thorium-CANDU system is planned.
3. Spent fuel reprocessing, plutonium recycle, and HLW vitrification.
4. Development of a waste repository (probably in granite).

US DOE/Indian Cooperation

1. Technical exchange between the US DOE and India is restricted to joint participation in international committees, conferences, and workshops. Because India is about to start up a plant for HLW vitrification and is working on geologic isolation and other waste management technology, there is a potential advantage to both countries in direct bilateral information exchange.
2. In 1982, R. W. McKee of PNL and J. A. McBride of E. R. Johnson Associates visited the newly constructed HLW vitrification and ILW bitumenization facilities at Tarapur on December 10, 1981. The visit followed their participation in a meeting of the IAEA Technical Committee on Interim Storage of and Techniques for Handling Conditioned High-Level Waste held in Bombay.

ITALY

Fuel Cycle Programs and Plans

1. Limited uranium mining and milling to start about 1987 (170 tonnes/yr).
2. LWR capacity: 1.26 GWe (1981), 7.3 GWe (1990); FBR capability.

3. Spent fuel reprocessing, plutonium recycle to domestic FBRs (potential), HLW vitrification.

4. Development of a waste repository (probably argillaceous).

US DOE/Italian Cooperation

1. Technical exchange between Italy and the US DOE occurs mainly through joint participation in international agency activities. These activities are augmented by infrequent survey visits to Italian and US DOE sites. Italian representatives have suggested a bilateral agreement, but at present there seems little incentive for the US to enter into a formal arrangement.

2. A. Donato of CNEN-CSN visited ORNL and SRL in April 1982 to review US DOE waste management R&D activities. J. L. McElroy of PNL visited Casaccia and Trisaia in September 1982 to review Italian HLW vitrification activities, and D. R. Anderson of Sandia briefed Italian officials at CNEN in February 1982 on activities of the Seabed Working Group.

JAPAN

Fuel Cycle Programs and Plans

1. Very small uranium production--3 tonnes in 1981.

2. LWR capacity: 16.0 GWe (1981), 19.8 GWe (1985), 51 GWe (1990); FBR capacity: 0.3 GWe (1985).

3. Fuel fabrication, enrichment, spent fuel reprocessing and plutonium recycle; HLW solidification (probably vitrification).

4. Development of a geologic or seabed waste repository, ocean dumping of non-high level waste.

Bilateral Agreement

Status

An LMFBR bilateral agreement became effective January 31, 1979, and covers a 10-year period. Reprocessing and waste management are covered in riders to the agreement.

Participants

The Power Reactor and Nuclear Fuel Development Corporation of Japan (PNC) and US DOE.

Technical Scope

Exchange of information, personnel, equipment and materials; joint projects including the use of facilities of the other party. Areas of technology include fuel cycle, fuels and materials, and economic and environmental considerations.

Program Status

In March 1981, the US DOE and PNC agreed to engage in a cooperation assessment of the safety of transport systems for special nuclear materials under normal and accident conditions. The assessment, to be completed in four years, is being performed by Sandia Laboratories (R. M. Jefferson). PNC is paying the US DOE $941,000 for the effort, which includes fire and collision tests. One-quarter-scale tests, including vehicle impact tests, have been completed. A full-scale test is planned for the summer of 1983.

Establishment of a Joint Working Group on Waste Management under the Japan/US DOE cooperative LMFBR agreement was agreed to in a meeting between PNC and DOE representatives at Germantown in October 1980 and approved by the Joint Coordinating Committee in November 1980. The first Working Group meeting met on October 12-15, 1981, in Tokyo. At this meeting, it was agreed to pursue exchange in the following areas:

- HLW solidification
- geologic waste disposal
- TRU waste treatment

- waste form and materials technology and characterization technology
- engineered storage of wastes
- waste canister development.

In FY 1982, thirteen Japanese teams (64 personnel) visited various US sites (ORNL, PNL, SRL, ONWI, HEDL, RF, ENICO, ANL, and DOE-Hq) to view and discuss waste management activities. Three US teams (12 personnel) reciprocated by visiting Japan on waste management topics.

As a result of suggestions made at the October 1981 waste management meetings, representatives of PNC and US DOE met first in Washington, D.C., on December 11, 1981, and later in Tokyo on February 25, 1982, to complete plans for a new Working Group on FBR Fuel Reprocessing. Areas identified for exchange are listed below, with exchange on the first two to begin immediately.

- criticality
- remote systems
- dissolution
- extraction
- offgas cleanup
- Pu conversion
- transportation
- safeguards, safety, and QA
- reprocessing experience
- plant design.

Active planning is under way on remote handling and criticality; however, implementation is awaiting approval of the agreement by the Japanese Diet, now expected in January 1983. In FY 1982, three Japanese teams (12 personnel) visited US sites (PNC, BNL, SERI, LBNL) to discuss fuel reprocessing and plant design activities. One US team (5 personnel) visited Japan on topics related to fuel reprocessing.

SWEDEN

Fuel Cycle Programs and Plans

1. No uranium production; also relies on foreign conversion and enrichment services.

2. LWR fuel fabrication.
3. LWR capacity: 6.4 GWe (1981), 9.4 GWe (1990).
4. Foreign reprocessing of Swedish spent fuel.
5. Granite repositories for all radioactive wastes and possibly spent fuels.

Bilateral Agreement

Status

The agreement expired June 30, 1980, and was renewed September 8, 1980, for a 5-year period.

Participants

Swedish Nuclear Fuel Supply Company (SKBF) and US DOE.

Technical Scope

The objective of cooperation under the agreement is to maintain, for the mutual benefit of both parties, a reasonably balanced exchange of information in the management of radioactive wastes and to engage in cooperative programs for field-testing experiments and techniques related to measuring the performance characteristics of a granite rock system, utilizing the Stripa Mine in Sweden, to assess the suitability of such rock types for terminal storage of radioactive material.

The areas of cooperation covered by the agreement include:

1. Preparation and packaging of waste forms
2. Surface and subsurface storage
3. Characterization of geologic formations
4. Field and laboratory testing
5. Disposal in geologic formations
6. Operational considerations
7. Environmental and safety considerations
8. Institutional and public relationships.

Other areas of cooperation may be added by mutual agreement in writing. The cooperation includes exchange of personnel, technical information, samples, materials, and instruments; conduct of seminars; visits to R&D facilities; and joint experimental projects.

Program Status

From 1977 to 1980, in situ tests to measure water movement through fractured granite and to assess the effect of heat on the rock system were conducted in a joint Lawrence Berkeley Laboratories (LBL)-SKBF/KBS program at the Stripa Mine located in central Sweden. This was followed by a multinational, in situ test program at Stripa, coordinated by OECD/NEA, which started in 1980. Phase I of the program (1980-1982) will provide information on buffer performance, hydrogeologic effects, ion migration in rock fractures, and rock stress conditions. Phase II, starting in 1983, will examine large rock volumes, three-dimensional migration, and borehole sealing.

The US DOE also is participating in the INTRACOIN project, a multinational project organized by the Nuclear Power Inspectorate in Sweden. The project compares different mathematical models describing the transport of radioactive nuclides in geologic media. The effort includes three phases: 1) comparison of accuracies of various codes on the same problem, 2) evaluation of codes' abilities to describe in situ measurements, and 3) evaluation of ability of codes to accommodate physiochemical efforts. The US DOE cooperated in the initial phase, completed in 1982. In 1983, the US DOE is involved only to complete reports on Phase I. Other participants are Canada, Finland, Federal Republic of Germany, France, Israel, Switzerland, and the United Kingdom.

In FY 1981, two Swedish visits (10 personnel) were made to US sites, including PNL and RHO. Seven US DOE groups (16 personnel) visited Swedish sites, including Ringhals, the Stripa Mine and SKBF/KBS. The topics discussed included low-level waste treatment, D&D, transport of radionuclides in geologic environments and geologic disposal.

SWITZERLAND

Fuel Cycle Programs and Plans

1. Rely on foreign sources for uranium, conversion, enrichment, and fuel fabrication.
2. LWR capacity: 1.94 GWe (1981), 3.8 GWe (1987).
3. Foreign reprocessing of spent fuels.
4. Crystalline rock repositories for all radioactive wastes.

US DOE/Swiss Cooperation

1. Limited bilateral information exchange is occurring. Now that the Swiss utilities have mounted a major effort to locate and evaluate a geologic repository, there may be US incentive (as well as Swiss) for expanded cooperative effort.
2. N. Gernstein of the US DOE visited the Bernese Power Company in May 1982 to discuss potential Swiss participation in TMI cleanup activities. D. J. Isherwood of LLNL visited the Underground Research Facility at Grimsel and the Institute for Reactor Research at Baden in October 1981 to review the Swiss repository programs. PNL in the US was visited by Dr. G. Bart of EIR at Würenlingen in February 1982 for discussions on high-level waste package design, quality control, and waste form characterization.

UNITED KINGDOM

Fuel Cycle Programs and Plans

1. No domestic production of uranium.
2. Conversion of uranium, enrichment, fuel fabrication.
3. GCR and AGR capacity: 10.7 GWe (1981); 13.3 GWe (1988); total (GCRs, LMFBRs, and LWRs): 25-40 GWe (2000).
4. Reprocessing of domestic and foreign spent fuels; vitrification of HLW; recycle of plutonium.

5. Extended engineered storage (>50 years) of vitrified HLW.

6. Sea dumping of solidified LLW; development of geologic and deep ocean disposal technology for high-level and TRU wastes.

Bilateral Agreement

Status

Waste management information exchange is covered by the UK-US LMFBR agreement, entered into force September 20, 1976 for a period of 5 years. On August 12, 1981, it was extended until December 20, 1986.

Participants

United Kingdom Atomic Energy Authority (UKAEA) and US DOE.

Technical Scope

Exchange of information, personnel, equipment and materials; visits and seminars; joint projects including the use by one party of the facilities of the other party. The scope includes both fuel reprocessing and waste management.

Major attention to date in the waste management area has centered on the treatment of plutonium-contaminated (TRU) materials. Eight topical areas have been established: controlled air incineration, acid digestion, sodium contaminated waste, ash treatment and immobilization, waste assay, size reduction and decontamination, reduction of arisings, and system studies. Other topics of interest include conditioning of HLW, hulls, various types of non-HLW liquid and solid wastes, and volatiles; process instruments; retrievable storage; and disposal.

Similarly, eight topical areas of exchange have been identified for fuel reprocessing--disassembly and shearing, heat generation and transfer, dissolution, flowsheet development, process instrumentation, analytical measurements, contactor, and remote technology.

Program Status

Extensive exchange of information has occurred and is occurring through reciprocal visits and document exchange. In FY 1982, three British visits (12 personnel) were made to US sites, including ONWI, AGNS, INEL, RF, RHO, PNL, and LANL. Twelve US visits (20 personnel) were made to UK sites, including Aldermaston, Harwell, Springfields, Risley, Dounreay, NRPB, CEGB, and Berkeley Laboratory. Waste treatment was the principal topic of interest; spent fuel storage, waste disposal, reprocessing, and environmental releases were also covered during the visits.

The most active exchanges are those on fuel reprocessing and TRU waste treatment. Representatives of the US and UK Ad Hoc Fuel Cycle Steering Committee under the US DOE/UKAEA Exchange Agreement in LMFBR Technology met in Risley, England, on November 16-17, 1981, to review progress in the past year in this area of the exchange and to develop plans for the program for the coming year. Despite budget problems in both countries, the value of the exchange is clearly recognized and agreement was reached to continue several existing areas of the exchange and to explore expansion of the agreement to several new areas. A US/UK seminar on solvent extraction was held in October 1982. Another seminar on remote handling has been proposed, and a cooperative effort on laser cutting of fuel is under way.

A major exchange of technology between the US DOE and UK on TRU waste treatment took place at the Workshop on the Design of Size Reduction and Sorting Facilities held in Albuquerque in May 1982. Over fifty persons participated. The United Kingdom sent nine persons, representing the Aldermaston, Dounreay, Harwell, and Windscale (Sellafield) sites. The US DOE provided participants from all major sites except Brookhaven and Mound.

INTERNATIONAL AGENCY PROGRAMS

Participation in the work of the international agencies active in the waste management field is reported in this section. Appendix A includes listings of symposia, workshops, and committee meetings sponsored by the Commission of the European Communities (CEC), the International Atomic Energy Agency (IAEA), and the OECD Nuclear Energy Agency (OECD/NEA).

COMMISSION OF THE EUROPEAN COMMUNITIES (CEC)

The CEC sponsors or cosponsors (with the IAEA or OECD/NEA) workshops, conferences and symposia. The agency also taxes its Member States and funds waste management research and development through two mechanisms.

1. Direct action programs are funded wholly by the CEC and carried out at Joint Research Center laboratories, primarily the Institute of Ispra, Italy.
2. Indirect action programs are conducted at laboratories and institutes of the Member States, and funded partly (up to 50%) by the CEC. These programs are scoped in a series of multi-year plans. The CEC's second 5-year plan for 1980-1989 includes studies in the following areas:
   - immobilization of low- and intermediate-level waste
   - conditioning of highly active solid wastes (e.g., cladding hulls)
   - treatment of medium-level liquid wastes
   - treatment of alpha-emitting wastes
   - testing and evaluation of solidified high-level wastes
   - immobilization and storage of gaseous wastes
   - shallow-land burial
   - storage and disposal in geologic formations

- evaluation of processes, tentative criteria, and waste management strategies
- studies relating to the legal, administrative, and financial aspects of waste management
- research and training program concentrating on the safety of the plutonium fuel cycle.

The Member States are contractually obligated to secure CEC approval for the release of technical results obtained in indirect-action R&D programs to non-CEC countries (e.g., the US). This requirement puts an additional constraint on bilateral information exchange between the Member States and the US on any such activity. Hence, a formal exchange agreement between the CEC and DOE would benefit the US as well as the CEC Member States. Negotiations toward such an agreement began 2 years ago and culminated in the signing of a 5-year agreement beginning October 6, 1982.

During FY 1982, US DOE representatives participated in CEC-IAEA-NEA sponsored symposia on Conditioning of Radioactive Wastes for Storage and Disposal at Utrecht in June 1982. G. L. Tingey of PNL and M. J. Stephenson of ORNL attended the CEC Specialists Meeting on Methods of Kr-85 Management at Brussels in June 1982.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

In pursuit of its goals to ensure the safe operation of nuclear installations and the protection of man and his environment from the harmful effects of nuclear radiation and releases of radioactive materials into the environment, the IAEA:

- Develops mutually agreed upon safety standards and criteria for the management and disposal of radioactive wastes generated in every stage of the nuclear fuel cyle.

- Promotes information exchanges in the radioactive waste management area through international conferences and symposia (often as a cosponsor with another agency), technical committees and advisory groups, and specialized training courses and seminars.
- Coordinates very limited-scale research programs in specific technical areas.
- Prepares technical reports and other publications in the field of waste management.

As a Member State of the IAEA and the United Nations (IAEA's founding organization), the US participates extensively in IAEA activities, sending delegates to symposia, workshops and committee meetings, and providing experts (often cost-free) for IAEA advisory groups and for specific IAEA studies. Major IAEA programs in which the US participates are: Safeguards Accountability of Nuclear Material, Nuclear Safety and Standards, Scientific Information Exchange, International Spent Fuel Management, and Technical Assistance.

During FY 1982, the US DOE participated in three IAEA international symposia and conferences. The Symposium on the Application of the International Commission on Radiological Protection Dose Limitation System (ICRP-26) in Nuclear Fuel Cycle Facilities, held in October 1981, was attended by D. A. Waite of ONWI. The US DOE was also represented at the IAEA/OECD/CEC sponsored International Symposium on Conditioning of Radioactive Wastes for Storage and Disposal, held in June 1982, at Utrecht in the Netherlands, and the IAEA's International Conference on Nuclear Power Experience held in Vienna on September 13-17, 1982. Much of the consultant expertise which the US DOE provided IAEA was assistance in drafting official IAEA documents. Seven scientists from the US visited Vienna to help prepare reports on various subjects--offgas treatment, waste acceptance criteria, decontamination and decommissioning, performance of geologic isolation systems, and shallow-land burial.

During FY 1982, US DOE representatives participated in meetings of the following IAEA committees and working groups:

- Research Programme on the "Use of Installed Instrumentation in Irradiated Fuel Reprocessing Facilities for Safeguards Purposes"
- Technical Committee on the "Treatment of Low- and Intermediate-Level Radioactive Liquid Waste"
- Technical Committee on "Interim Storage of and Techniques for Handling Conditioned High-Level Waste"
- Third IAEA/GESAMP Working Group Meeting on "Oceanographic Dispersion Model for Waste Disposal in the Deep Sea"
- Research Programme on "Environmental Migration of Radium and Other Contaminants."

OECD NUCLEAR ENERGY AGENCY (NEA)

The main purpose of the NEA is to promote international cooperation among the OECD countries for the development and application of nuclear power for peaceful purposes. With a small staff and limited funding, the NEA's efforts are restricted to sponsorship or cosponsorship of symposia, seminars, working groups and committees concerned with various radioactive waste management problem areas. Recently the NEA has also undertaken the coordination, though not the funding, of multinational projects such as the proposed test program at the Stripa Mine in Sweden, the Seabed Working Group activities, and the International Radionuclide Sorption Information Retrieval Systems. In FY 1982, the NEA cosponsored, with the IAEA and CEC, the "International Symposium on Conditioning of Radioactive Wastes for Storage and Disposal" at Utrecht, Netherlands in June 1982.

During the report period, DOE representatives have participated in meetings of the following NEA committees and working groups:

- Specialists Workshop on Techniques for the Dry Storage of Spent Fuel Elements
- Workshop on Waste Form Evaluation and Testing

- First meeting of the ad hoc Legal and Institutional Task Group of the NEA Seabed Working Group
- Workshop on Geochemistry and Radioactive Waste Disposal
- Coordinating Group on Geologic Disposal
- Technical committee meeting to review the ISIRS project
- Meeting of the Site Task Group of the Seabed Working Group
- Meeting of the Coordinating Group of the Seabed Working Group
- Research Planning Meeting for the Seabed Working Group
- Meeting to define Phase II research programme for the Stripa Project
- First joint meeting of the Research Task Groups of the NEA Executive Group for Research on Sea Disposal of Radioactive Waste
- Second meeting of the Executive Group for Research on Sea Disposal of Radioactive Waste
- Working Group subcommittee meeting on Circulation Modeling for Seabed Disposal of Nuclear Wastes
- Workshop on Geophysical Investigations in Connection with Geologic Disposal of Radioactive Waste.

OTHERS

US DOE representatives participated in several other activities sponsored by other organizations:

- FRG-sponsored Annual Nuclear Conference
- European Nuclear Society Conference
- UK-sponsored International Conference on Fast Reactor Fuel Cycles
- MRS-sponsored Fifth International Symposium on the Scientific Basis for Nuclear Waste Management
- SSS-sponsored International Soil Sciences Congress

- Third International Symposium on Mining and Metallurgy (UK)
- Eleventh Conference of the International Association on Water Pollution Research
- ISO-sponsored meeting of the Working Group on Standardization of Measurement Methods for the Characterization of Solid and Solidified Waste Forms and for the Corrosion of Primary Containers
- INTRACOIN-sponsored workshop on radionuclide transport modeling
- UNESCO-sponsored meeting of experts on Scientific Aspects of Marine Pollution (GESAMP).

BENEFITS

US DOE technical experts have participated in symposia, technical seminars, workshops, and working groups sponsored by the CEC, IAEA, and OECD/NEA. With the present high level of foreign expertise in the nuclear fuel cycle and the advanced state of foreign technology, the information exchanges have provided wide dissemination of technological information. All parties stand to benefit from major international studies such as NEA's Seabed Working Group, the IAEA spent fuel storage surveys, etc.

The benefits to be derived from an exchange program cover a wide spectrum and, as discussed in the Introduction, are both tangible and intangible. The United States, because of its early entrance into the nuclear energy field and its broad scope and experience, developed an early lead in technology. Exchange of technology on a quid-pro-quo basis was not possible until recent years and still is not possible with the less developed countries. In these cases, the benefits are intangible, e.g., raising standards of living in those countries.

In recent years, however, France, West Germany, the United Kingdom, and Japan have achieved technological parity, and in some cases, superiority in nuclear technology. With these countries, it is possible to exchange technology on a quid-pro-quo basis. Considering the current lack of activity within the US in closing the commercial fuel cycle, the US can gain much from the active fuel reprocessing and waste management programs under way in these countries.

Fiscal year 1982 has seen a continuation of the bilateral waste management technology exchanges which are proving more and more profitable. The general and more noteworthy specific benefits from these exchanges are summarized below.

FUEL REPROCESSING

As the basic technology for nuclear fuel reprocessing is available in the US from previous and on-going defense activities, most benefits to be gained

from international exchanges revolve around the application of fuel reprocessing to the commercial nuclear power cycles and the constantly evolving guidelines imposed by regulatory agencies on environmental releases, worker exposures, and waste disposal. And unlike nuclear power production, reprocessing technology is available from only a few programs. The US has gained, and can gain, benefits from access to:

Belgium:	experience in past and planned future reprocessing at Eurochemic
	experimental and theoretical studies of CEN/SCK, with emphasis on current studies on head-end offgas treatment
	cleanup of the Eurochemic reprocessing plant showing that such a facility can be decontaminated completely after extensive use
FRG:	experience in "hot" reprocessing at WAK
	experimental and theoretical studies at various sites with emphasis on current studies on electroprocesses to reduce salt addition, modeling of extraction processes, tritium confinement within process systems, dissolver residue characterization and treatment, and remote design features
France:	experience in "hot" reprocessing at Marcoule and La Hague
	experimental and theoretical studies at various sites
India:	experience in "hot" reprocessing at Trombay, Tarapur, and Kalpakkam
	laboratory and theoretical studies at BARC
Italy:	radioactive R&D on fuel reprocessing at EUREX and ITREX
Japan:	experience on "hot" fuel reprocessing at Tokai-mura

demonstration of FBR reprocessing in the FBR Fuel Reprocessing Facility

R&D studies, including radioactive development testing in the new Chemical Processing Facility

experimental and theoretical studies at various sites with current emphasis on co-processing and remote design features

UK: experience in fuel reprocessing at Windscale and Dounreay

experimental and theoretical studies at several sites with current emphasis on fuel shearing and disassembly, instrumentation analytical laboratory technology, contactor design, remote design features, and breeder fuel fabrication

IAEA: reviews and studies of reprocessing technologies, safety, and plutonium storage

OECD-NEA: past and possible future experience at the Eurochemic fuel reprocessing facility

CEC: reprocessing R&D at Ispra (Italy), Mol (Belgium), Petten (Netherlands), and Karlsruhe (FRG)

HIGH-LEVEL WASTE (INCLUDING SPENT FUEL)

Most of the countries with HLW treatment and immobilization programs have benefited significantly from US-developed technology. For example, the concept of using a joule-heated ceramic melter for vitrifying HLW was started in the US in the early seventies. It is now the preferred system in the US, FRG, and Japan. In turn, the US has gained, or can gain, from access to:

Australia: laboratory and pilot-scale testing on the SYNROC waste form (this waste form was conceived in Australia and is

	presently being evaluated in the US as the most likely alternative to borosilicate glass should an alternative be required)
Canada:	studies of dry spent fuel storage (interim and terminal)
FRG:	ceramic melter development program, particularly remote-handling features and offgas treatment (the West German vacuum transfer system has been incorporated into the SR DWPF design)
	designs and experience on dry storage/transportation systems (the CASTOR dry storage system originating in the FRG has aroused high interest in the US)
	glass form development and characterization, particularly on glass-ceramics and glass/metal composites
	PAMELA pilot plant at Mol
France:	actual experience on and demonstration of radioactive waste vitrification (AVM) (although exchange to date has been limited)
	the engineered dry storage of vitrified high-level wastes
Japan:	studies in new hot cell facilities for HLW vitrification and waste form characterization, owned by PNC and by JAERI
UK:	the experience at Windscale on high-level liquid-waste storage
IAEA:	evaluations of alternative technologies for spent fuel (1981-82)
	joint research program with NEA on behavior of spent fuel in water-filled storage basins

supporting documentation and personnel for IAEA reports on treatment of high-level waste

CEC: R&D on actinide separation to minimize quantities of high-level waste

characterization studies (radiation damage, leaching, waste-rock interactions) on borosilicate glass waste form

TRANSURANIC WASTE

The US, more than most other countries, greatly emphasizes this class of non-high-level waste as requiring segregation and special disposal. Because of this factor and the relatively large defense-related operations producing TRU waste, the US has developed extensive technology in this area. Among the other nations, only UK and France have defense activities producing significant quantities of TRU wastes. However, the UK, France, FRG, Japan, Italy, and India have power programs that also produce TRU wastes during reprocessing. As the reprocessing wastes differ considerably from defense TRU wastes, the US stands to obtain much TRU waste technology from exchanges with these countries.[a] The US has gained, or can gain, from access to:

Belgium: the TRU experience at the Eurochemic reprocessing program and the MOX plant at Dessel

the experimental and theoretical studies on TRU wastes with current emphasis on acid digestion, slagging incineration, solvent conditioning, and form characterization

the experience in incineration and immobilization of TRU wastes into cement and bitumen

the engineered storage of TRU wastes

(a) See report by R. Y. Lowrey, et al., Evaluation of the United Kingdom and Federal Republic of Germany Technologies in the Field of Plutonium-Contaminated Nuclear Waste, TWSO-100-80, July 12, 1982, for a comprehensive review of TRU waste technology in the UK and FRG.

	the acid digestion plant at Mol, supply by FRG, now in operation for Eurochemic TRU wastes
FRG:	the experience at the WAK reprocessing facility and Alkem MOX plant
	the experimental and theoretical studies under way at several sites with current emphasis on acid digestion, chemical separation of actinides from wastes, cladding and waste form characterization, and immobilization of TRU wastes in glass, asphalt, and cement
	the engineered surface storage of TRU wastes
	assay of MOX fuels
	size reduction and decontamination of solid wastes
	pyrolysis of contaminated organic solvents
	pyrohydrolysis of combustible wastes to facilitate greater recovery of plutonium
France:	the TRU waste experience gained with MOX fuels fabrication and reprocessing at various sites including plutonium recovery from wastes, cryogenic volume reduction, and incineration
	experimental and theoretical studies with current emphasis on volume reduction of liquid wastes using distillation or membrane processes, decontamination by chemical or electrochemical scouring, acid digestion, various waste forms (bitumen, resin, glass, concrete), decontamination and treatment of cladding hulls
India:	the TRU waste experience gained with MOX fuel fabrication and spent fuel reprocessing at various sites
	experimental and theoretical studies with current emphasis on partitioning, aluminosilicate waste forms, and cladding densification

Italy:	the TRU waste experience gained with MOX fuel fabrication and spent fuel reprocessing at various sites
	experimental and theoretical studies with current emphasis on partitioning
Japan:	the TRU waste management experience gained with MOX fuel fabrication and spent fuel reprocessing at various sites
	experimental and theoretical studies with current emphasis on acid digestion, incineration, electroslag melting, microwave melting, and compaction of cladding hulls
UK:	the TRU waste treatment experience gained with plutonium fuel fabrication and spent fuel reprocessing at various sites
	experimental and theoretical studies with current emphasis on minimization of waste generation, decontamination, acid digestion, sodium wastes, and immobilization
	size reduction and decontamination of solid wastes
	incineration of wastes (the Windscale incinerator was a pattern for a similar unit built at Savannah River)
	assay of reprocessing wastes and MOX fuels
IAEA:	technical background material from various countries used in preparation of technical reports on TRU waste
OECD-NEA:	technical background from various countries on the treatment of intermediate-level waste (often classified as TRU waste)
CEC:	studies on actinide separation (to reduce waste generation)

R&D on treatment of highly radioactive solid waste (fuel cladding and dissolution residues)

R&D on volume reduction and immobilization of TRU waste

development of actinide monitoring instrumentation

LOW-LEVEL WASTE

As most countries treat their low-level and TRU waste similarly, the benefits noted in the TRU section generally apply to low-level waste also. Power plant wastes constitute the bulk of the low-level waste produced outside of mining and milling. The technologies for handling such wastes (compaction, cementation, bituminization) are reasonably well developed and are readily available through commercial channels. Planned technology exchanges on treatment of these wastes would probably not produce many benefits over those being obtained by the on-going exchange via commercial channels and participation in international symposia, seminars, and workshops.

AIRBORNE WASTE

Most of the new technology to be gained by the US through international exchanges will arise through the reprocessing and waste vitrification programs under way in the more developed countries. The US has gained, or can gain, from access to:

Belgium: tritium separation and enrichment studies

dissolver offgas mockup facility for testing iodine, NO_x, and krypton removal from offgas

studies of the volatilization of radionuclides during waste vitrification

Canada: studies on the recovery and immobilization of iodine, carbon-14, krypton, and tritium from gaseous effluents

FRG:	extensive laboratory and pilot-scale experimental programs on management of radioactive particulates, radioiodines, carbon-14, tritium, and krypton-85
	actual radioactive experience in control of particulates and radioiodines at the WAK reprocessing plant
France:	extensive laboratory and pilot-scale experimental programs on management of radioactive particulates, radioiodines, krypton-85, and tritium
	actual radioactive experience in control of airborne waste at Marcoule and La Hague reprocessing centers
UK:	extensive laboratory experimental program on control of radioiodines, tritium, and krypton-85
	actual radioactive experience on control of particulates and radioiodines at the Windscale reprocessing facility
IAEA:	reviews of national policies on releases of airborne waste
	technical background material provided by various countries on the treatment of airborne waste
OECD-NEA:	activities of the expert group on Release of Effluents from the Nuclear Fuel Cycle, which is producing summary and policy reports on releases of long-lived radionuclides (H-3, C-14, Kr-85, I-129) from nuclear operations
CEC:	R&D on immobilization and storage of gaseous waste

WASTE DISPOSAL

As in the case of reprocessing and waste treatment technology, the US gained an early lead in the development of waste disposal technology. The current policy of shallow-land burial for low-level waste and geologic disposal

for high-level and transuranic wastes has evolved from numerous evaluations that also included sea dumping, disposal in space, transmutation, and extended engineered storage. Among other nations, geologic isolation appears to be preferred for all wastes, although disposal to the sea and extended surface storage in engineered structures are gaining interest. The US has gained, or can gain, from access to:

Belgium:	experience and data from Belgium's demonstration disposal facility in clay (Project HADES) for high-level and TRU wastes
	experience in sea dumping of low-level solid waste
Canada:	experience in identifying and characterizing potential sites for geologic repositories in granite
	laboratory and theoretical studies on radionuclide migration in the environment
	studies of rock mechanics
	development activities on repository design, e.g., vault backfilling and sealing techniques
	experience in planning and operating the Underground Research Laboratory
Denmark:	experience in identifying and characterizing potential salt dome structures for disposal of high-level wastes
FRG:	experience in identifying and characterizing salt deposits for disposal of radioactive wastes
	experience in designing salt mine waste repositories
	experience in disposing of LLW and ILW at the Asse salt Mine
	experience in disposing of LLW and D&D wastes in Konrad Iron Mine
	studies of the disposal of tritium in deep wells

France:	R&D studies on disposal in geologic granitic formations and on seabed disposal
	experience in solid LLW disposal using engineered surface structures
Italy:	R&D studies on disposal in clay
Japan:	R&D studies on seabed dumping
Netherlands:	design of repositories in salt
Sweden:	R&D and design on an underground waste repository in granite
	design of waste package and backfill
	studies on underground movement of radionuclides
Switzerland:	selection and characterization of potential repository sites in granite
UK:	extensive R&D on disposal in geologic repositories, on the seabed, and under the seabed
	experience in sea dumping of solid LLW
	experience in discharge to sea of low-level liquid waste
IAEA:	supporting documentation used in preparation of IAEA Safety Series documents, Safety Guides, and technical reports
	studies of repository design, including waste acceptance criteria
	safety analyses, preparation of codes and guides, and reviews of regulatory procedures for underground disposal

OECD-NEA: International Sorption Information Retrieval System (ISIRS) Project, an international bank of geologic sorption data on radionuclides

the in situ test program in the Stripa Mine in Sweden

the Seabed Working Group which promotes information exchange and cooperation in seabed waste disposal studies.

APPENDIX A

LOG OF BILATERAL EXCHANGES

INTERNATIONAL SYMPOSIA AND CONFERENCES

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
AUSTRALIA				
AT Duff (Lucas Heights)	ANL, ORNL (June 1, 1982)	Obtain an overview of radioactive waste management practices in the US	---	AS-82-001
Prof. RE Segall (Griffith Univ.)	PNL, LLNL, SNL, LANL (September 1982)	Technical exchange--leaching studies and microstructural properties of SYNROC materials	---	AS-82-002
BELGIUM				
A Bonne (CEN/SCK)	PNL, Rockwell Hanford (March 22, 1982)	Technical exchange--geologic disposal; safety analysis	---	BE-82-001
AA Bauer (ONWI) CR Cooley (COE)	CEN-SCK (October 1981)	Review Belgian geologic waste disposal program; inspect the Belgian subsurface test facility (HADES) at Mol	---	BE-82-002
JD Sease, JE Vath (ORNL)	CEN-SCK (October 1981)	Review Belgian geologic disposal program and safety analysis	---	BE-82-003
AG Blasewitz (HEDL)	Eurochemic, SCK/CEN (June 1982)	Review Belgian R&D waste management	---	BE-82-004
N Gerstein (DOE)	CEN-SCK (June 1982)	Discuss potential Belgian participation in TMI cleanup	---	FR-82-007
LT Lakey (PNL) R Allhoff (DOE-SRO) GK Oertel (DOE)	CEN-SCK (October 1, 1981)	Tours of facilities and technical discussions--waste management programs	---	GW-81-054

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
CANADA				
WF Ubbes (ONWI)	Canada/AECL-Whiteshell (October 8-9, 1981)	Participants in URL Project Management Committee meeting	Yes	CA-82-001
TE Rummery and Whiteshell team (7)	ONI/ONWI, Columbus (January 12-13, 1982)	Review of the Memorandum of Understanding for Cooperation in Radioactive Waste Management; discuss future cooperation on HLW and spent fuel disposal systems	Yes	CA-82-002
CHINA (PEOPLE'S REPUBLIC)				
GU Guoying (Academia Senica)	Rockwell-Hanford (March 2, 1982)	Technical discuss--BWIP; measurement of impurities in uranium and plutonium	---	CH-82-001
Gu Yu-ming (2nd Ministry of Machine Building) Zhang Yao-Hua, Wu Shi-bin, Zhang Tian-xiang, Quan Wei-jun (Quinghua University)	NFS, PNL, ORNL, BNL, Bechtel, DOE-GTN (May 1982)	Learn about LLW disposal activities in the US	---	CH-82-002
DENMARK				
M Kehnemuyi (ONI)	Elkraft-Elsam power companies (November 18-19, 1981)	Attend symposium on Danish salt dome repository studies	---	DA-82-001

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
FRANCE				
AG Blasewitz (HEDL)	Marcoule, Cadarache (July 1982)	Review French waste disposal R&D	---	BE-82-004
EM Arnold (PNL)	Institut National de Recherche en Informatique et en Automatique (September 5-October 5, 1981)	Guest lecturer; technical exchange--hydrology	---	FR-81-013
AA Bauer (ONWI) CR Cooley, DG Boyer (DOE) DJ Isherwood (LLNL) BR Erdal (LANL) RJ Serne (PNL)	CEA-Paris (October 21-23, 1981)	Technical exchange--radionuclide migration and hydrogeological studies. Discussions of US/France exchange agreement	---	FR-82-001
P Jourde (CEA-Cadarache)	ORNL, PNL, DOE November 1981)	Review US waste management technology; discuss potential DOE/CEA information exchange	---	FR-82-002
DA Waite (ONWI)	CEA (October 1981)	Review of French waste handling experience and dosimetric calculations	---	FR-82-003
D Rancon	PNL, LANL (March 1982)	Technical exchange--radionuclide migration and retention in soils	---	FR-82-004
J Lefevre, N Sugier (CEA) P Jourde (CEA-Cadarache)	DOE-Germantown (March 1982)	Start formal negotiations toward a CEA/DOE bilateral waste management exchange agreement	---	FR-82-005

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
FRANCE (contd)				
DE Knowlton (PNL)	Marcoule (October 1-2, 1981)	Technical exchange--techniques for solidifying medium- and low-level wastes	---	FR-82-006
N Gerstein (DOE)	CEA, EDF, SGN and other companies (May 1982)	Discuss potential French participation in TMI cleanup	---	FR-82-007
E Chennevier, B Ancelin (ANDRA)	ONWI, ANL, ORNL, NTS, LLNL, SNL, PNL, RHO (August 1982)	Technical discussions--US waste management programs	---	FR-82-008
J Teillac, J Lefevre, LeNiger (CEA) Barre (Embassy) Paredis, Cameron (COGEMA)	TMI, DOE-GTN (August 1982)	Review TMI cleanup; discuss DOE/CEA bilateral agreement (proposed); discuss cooperation in TMI cleanup	---	FR-82-009
P Faugeras, A Jouan, GG Ranger (Marcoule)	SRL, PNL, LLNL (September 1982)	Technical discussions--HLW vitrification	---	FR-82-010
TD Chikalla (PNL) JF Kircher (ONWI) M Steindler (ANL)	Marcoule (March 21-April 2, 1982)	Review waste immobilization facilities and programs at Marcoule and at Karlsruhe	---	NEA-82-003
AR Robinson (Harvard U.)	Institut de Mecanique (January 1982)	Develop plans for intercomparison of ocean circulation models used by US, UK, FRG and France	---	UK-82-005

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG)				
AA Bauer (ONWI)	GSF/IfT and other FRG sites (July 1980-July 1982)	Long-term assignment to FRG	Yes	---
JD Sease, JE Vath (ORNL)	KfK (October 1981)	Review low-level waste treatment operations at KfK	---	BE-82-003
DA Waite (ONWI)	Asse Mine, PTB (October 1981)	Technical exchange--safety aspects of conducting radiological activities underground	---	FR-82-003
DE Knowlton (PNL)	KfK (October 1981)	Attend IAEA seminar; tour KfK facilities	---	FR-82-006
N Gerstein (DOE)	BMFT, KFA, KWU, NUKEM, KfK and other companies (May 1982)	Discuss potential FRG participation in TMI cleanup	---	FR-82-007
RR Hammer (ENICO)	KfK (7 weeks--September-November 1981)	Participate in KfK R&D on krypton recovery and purification	Yes	GW-81-023
B Grambow (HMI, Berlin)	PNL (May 1981-May 1982)	Long-term assignment to study HL waste form leaching	Yes	GW-81-024
LT Lakey (PNL) F Allhoff (DOE-SRL) GK Oertel (DOE)	KFA (October 2, 1981)	Tours of facilities and technical discussions--waste management programs	---	GW-81-054

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG) (contd)				
HLW team (15) from DWK, Kraftanlagen, Uhde, NUKEM KWU, LURGI	SRL, AGNS, PNL, ENICO, ORNL (October 1981)	Review US design of reprocessing and waste vitrification facilities; discuss HLW immobilization processes and technology	---	GW-82-001
AA Bauer (ONWI) CR Cooley (DOE)	Konrad Mine (October 1981)	Inspect the mine and test facilities	---	GW-82-002
HLW team (6) from WAK, NUKEM, HMI, KfK, DWK	SRL, Catholic University, sity, LLNL, PNL (October 1981)	Technical exchange--characterization and quality assurance of final waste forms	Yes	GW-82-003
K Ebert (KfK)	SRL, AGNS, ORNL, INEL, PNL (November 1981)	Review US waste management and fuel cycle R&D programs	---	GW-82-004
HLW team (8) from Uhde, LURGI, NUKEM, KWU	SRL, AGNS, PNL, GE-Midwest (November 1981)	Review US design of waste treatment facilities; discuss HLW management technology and maintenance concepts	---	GW-82-005
AM Platt (PNL)	KfK (December 2-5, 1981)	Participate as US representative in FRG Workshop on Properties and Qualifications of Waste Products for Disposal	---	GW-82-006
KD Closs, HJ Engelmann, OR Mehling (KfK) H Pirk (NUKEM) FW Papp (DWK)	PNL, HEDL, NTS, SNL, WIPP, Bechtel, Westinghouse-Hanford (November 27, 1981)	Technical exchange--spent fuel disposal; repository backfill studies	Yes	GW-82-007

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG) (contd)				
G Delisle (BGR)	PNL (October 28, 1981)	Technical exchange--computer modeling of temperature gradients in the Gorleben salt dome	---	GW-82-008
R Kroebel, R Kraemer, W Baehr, W Guber (KfK) G Kemmler, H-H Homann (NUKEM)	Rockwell-Rocky Flats (March 15, 1982)	Technical exchange--waste incineration and immobilization	---	GW-82-009
	ORNL (March 19, 1982)	Review ORNL/KfK cooperative R&D programs on cementitious waste forms; plan future exchange		
	NTS, LANL, Mound Laboratory (March 1982)	Technical exchange--waste treatment; review of DOE programs		
Dr Ache (KfK) Dr Gantner (KfK)	LANL (December 1981)	Technical discussions--TRU waste instrumentation program	---	GW-82-010
JA Carr, RB Laughon, SC Matthews, RA Robinson, SS Smith, AA Bauer (ONWI) G Boyer (DOE)	PTB (Braunschweig), Asse Mine, Konrad Mine (October 12-16, 1981)	Technical exchange--geologic waste isolation; tour Asse and Konrad mines	Yes	GW-82-012
Klaus Blaseck (DWK/KEWA)	SRL (February 2-5, 1982)	Technical exchange--HLW vitrification; remote operation and maintenance	---	GW-82-015
HLW team (11) from Uhde, LURGI, NUKEM, KWU, DWK	PNL, Rockwell-Hanford, GE-Morris Plant, ANL, AGNS-Barnwell, SRL (March 15-24, 1982)	Technical exchange--HLW management technology; plant design, operation and maintenance concepts	---	GW-82-017

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG) (contd)				
RP Randl, KD Kuhn, T Rothfuchs, E Schneider, V Schneider, FP Oesterle, A Wallner, S Halaszovich (BMFT and Research Institutes)	PNL, LLNL, Bechtel, WIPP, SRL, DOE-Germantown (April 1982)	Attend ANS meeting on waste management; review US programs; attend US/FRG waste management coordination meeting	Yes	GW-82-018
HO Denschlag (Univ. Mainz)	PNL, UC-Irvine (March 1982)	Technical discussions--fission product yields; actinide chemistry in soils	---	GW-82-019
HO Wingender (NUKEM)	PNL, ORNL, EPRI, General Atomic, SNL (March 1982)	Technical exchange--risk assessment and safety analysis for radioactive transport and fuel cycle facilities	---	GW-82-020
HLW team (6) from Uhde, DWK	PNL, Rockwell, GE-Morris, AGNS-Barnwell, SRL (May 1982)	Technical exchange--HLW management; remote operations and maintenance	---	GW-82-024
J Krekeler (GSF/IfT)	ONWI (November 1981-February 1982) SNL (February 1982) RE/SPEC (March 1982)	Long-term assignment to ONWI in connection with FRG/US waste isolation program	Yes	GW-82-027
K Wegner (NUKEM)	SRP, ORNL, LANL, General Atomics (April 1982)	Obtain US review of NUKEM concept for a remote handling unit for large hot cells	---	GW-82-029

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG) (contd)				
H-P Wichmann (KfK)	ENICO-Idaho, SRL (May 1982)	Assignment to ENICO to work on offgas treatment; visit to SRL to discuss airborne waste management	Yes	GW-82-030
TJ Headley (SNL)	HMI (June 1982)	Materials characterization research--6 week assignment	Yes	GW-82-033
ND Holder (General Atomic)	NUKEM, KFA (May 1982)	Coordinate GA and KFA spent fuel reprocessing head end tests (HTGR fuels)	---	GW-82-035
HG Bernrath, B Hirsch, P Laufs, G Volmer, B Bahr (German Parliament)	WIPP, NTS, PNL, DOE-GTN (August 1982)	Review US waste management programs as part of study for FRG parliament	---	GW-82-036
B Strasser (Uhde)	PNL (September 1982)	Review PNL waste vitrification technology; discuss remote operation and maintenance techniques	---	GW-82-037
PH Bruecher (KFA)	PNL (September 1982)	Technical exchange--safety problems related to liquid-fed ceramic melter operation	---	GW-82-038
R Neider (BAM and SSK)	NRC, ORNL, LANL, Hanford	Observe and discuss shallow land disposal in the US	---	GW-82-039
Uhde-LURGI-DWK-KfK team (7)	AGNS, SRL, PNL, RHO, GE-Morris (September 1982)	Technical exchange--HLW immobilization: plant design and maintenance	---	GW-82-040

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
GERMANY (FRG) (contd)				
RA Brouns, LK Holton, JL McElroy (PNL) CC Chapman (WVNS Co.) KR Routt (SRL)	KfK, Eurochemic-Belgium (September 1982)	Information exchange--HLW vitrification	Yes	GW-82-041
TD Chikalla (PNL) JF Kircher (ONWI) M Steindler (ANL)	KfK (March 1982)	Discuss KfK waste management R&D	---	NEA-82-003
LL Burger (PNL)	KfK (October 1-2, 1981)	Technical exchange--offgas treatment technology; solvent extraction; Pu extraction behavior	---	UK-81-025
AR Robinson (Harvard U.)	DHI (January 1982)	Develop plans for intercomparison of ocean circulation models	---	UK-82-005
WV Bergman (LLNL) JD Christian (ENICO) RS Eby (ORNL) WS Groenier (ORNL) TR Thomas (ENICO) AK Williams (AGNS)	KfK (April 20-23, 1982)	Workshop on Dissolver Offgas Treatment	Yes	---

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
IAEA				
DR Anderson (Sandia)	IAEA (February 12, 1982)	Brief IAEA waste management staff on Seabed Working Group	---	NEA-82-004
INDIA				
RW McKee (PNL) J McBride (E.R. Johnson Associates)	Bhabha Atomic Research Centre (BARC), Tarapur Atomic Power Station (December 7-11, 1981)	Tour Tarapur HLW vitrification plant (WIP)	---	IAEA-82-003
ITALY				
A Donato (CNEN-CSN, Casaccia)	ORNL, SRL (April 1982)	Review US waste management R&D activities	---	IT-82-001
JL McElroy (PNL)	Casaccia and Trisaia (September 1982)	Review Italian plans for HLW vitrification facilities	---	IT-82-002
DR Anderson (Sandia)	CNEN (February 11, 1982)	Brief Italian officials on the program of the Seabed Working Group	---	NEA-82-004

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
JAPAN				
S Meyers, A Perge (DOE) R Best (ONWI) J Crandall (SRL) K Gilbert (Rockwell-Rocky Flats) K Harmon (PNL)	PNC/Tokyo, PNC/Tokai-mura, Kobe Steel, Mitsubishi Metal, JAERI/Tokai-mura (October 12-20, 1981)	First PNC-DOE Working Group Meeting on Waste Management; tour Japanese waste management facilities and R&D programs	Yes	JA-82-001
Waste management team (7) from RWMC, MMC, Kobe Steel, U. of Kyoto, Sumitomo Cement, Meidensha Electric	ORNL (October 19, 1981)	Review US waste management technology and R&D programs	---	JA-82-002
17-person industrial group, sponsored by Radioactive Waste Management Center (RWMC), led by T Ishihara	PNL, SRL (November 9, 1981)	Attend MRS meeting in Boston; tour selected US DOE sites	---	JA-82-003
S Masuda, N Tsunoda (PNC)	ONWI, PNL, ORNL, SRL (November 1981)	Attend annual ONWI information meeting; visit US DOE waste management laboratories	Yes	JA-82-004
20-person team from Japanese utilities	PNL, HEDL (December 4, 1981)	Attend ANS meeting; review PNL waste management and HEDL LMFBR programs	---	JA-82-005
M Koizumi, H Ando, T Nomizu, M Kubo (PNC)	PNL, DOE-Germantown (December 1981)	Inspect PNL criticality safety laboratory and discuss possible US criticality safety studies for PNC	Yes	JA-82-006

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
JAPAN (contd)				
M Aoki (Hirosaki Univ.)	PNL (December 2, 1981)	Technical discussions--backfill and repository sealing research	---	JA-82-007
H Kuribayashi, K Imazono, S Sakata, J Yamamoto, A Fujita (JGC Corp)	Brookhaven, BMI (Columbus), SERI, PNL, LBNL (March 1982)	Gather information on management, organization and design layout of laboratories in the US	---	JA-82-008
S Tachimori (JAERI) Y Nakamori, S Sakamaki (Mitsui)	PNL, LANL (March 1982)	Facility and program review: criticality safety; waste management	---	JA-82-009
T Asao (Mitsubishi)	PNL (November 11, 1981)	Review PNL technology--spray calcination, pelletizing, waste immobilization in concrete	---	JA-82-010
T Morisue (Toshiba)	Rockwell-Rocky Flats, ORNL (March 1982)	Discuss nuclear waste management technology	---	JA-82-011
MJ Lawrence, C Bastin (DOE) WD Burch, MJ Feldman, OO Yarbro (ORNL)	PNC/Tokai-mura (February 17-25, 1982)	Exchange descriptive information on fuel reprocessing facilities in the US and Japan; discuss future bilateral cooperation in the fuel cycle area	Yes	JA-82-012
HLW team (7) from PNC and industry	PNL, ENICO, SRL (April 1982)	Program review--HLW vitrification R&D	---	JA-82-014

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
JAPAN (contd)				
GL Chipman, JA Leary, S Rosen (DOE) RB Richards (GE) JB Yasinsky (Westinghouse) GW Meyers (Rockwell Intl) CE Till (ANL)	PNC (May 11-14, 1982)	Attend fifth meeting of DOE/PNC Joint FBR Coordinating committee	Yes	JA-82-015
F Kawamura (Hitachi)	RRF (June 1982)	Discuss electrolytic decontamination of metal waste	---	JA-82-016
A Kawaguchi (PNC)	PNL (July 1982)	Review PNL decontamination R&D	---	JA-82-017
Dr Kawahara, Mr Asano (MMC)	ANL (May 1982)	Discuss actinide migration	---	JA-82-018
H Tasaka, K Maekawa, M Okamoto (Mitsubishi Metals)	PNL, ORNL (September 20, 1982)	Review DOE waste management programs	---	JA-82-019
S Tashiro (JAERI)	PNL (September 24, 1982)	Technical exchange--waste form characterization	---	JA-82-020
PA Witherspoon (LBNL)	PNC, Shimokaya Mine (April 1982)	Technical exchange--waste isolation	---	JA-82-021
WF Bonner, WJ Bjorklund (PNL) CC Chapman, JM Pope (WVNS) KR Routt (SRL)	PNC-Tokai Works, Kobe Steel, Nippon Electric Glass, Mitsubishi Metal, JAERI (September 1982)	Technical exchange--HLW vitrification, under PNC/DOE exchange agreement	Yes	JA-82-022

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
KOREA (ROK) (contd)				
Dr Yong Kyu Lim (AEC) Dr Lee Han Ju (KAERI Daeduk Eng Center) and four associates	NTS, INEL, ORNL, AGNS-Barnwell, DOE-Germantown, NRC (November 1981)	Review US nuclear fuel cycle and waste management programs and facilities	---	KS-82-001
ROK delegation (AEB, KAERI, KEPCO)	PNL, ORNL, DOE (June 1982)	Discuss potential PNL and ORNL studies for KAERI	---	KS-82-002
PHILIPPINES				
Government waste management team (5)	Rockwell, PNL, ORNL, AGNS (June 1982)	Review US waste disposal practices and policies; discuss disposal site selection criteria and evaluation	---	RP-82-001
SOUTH AFRICA				
HW Ahrens/Council for Scientific and Industrial Research	ORNL (November 1981)	Review US waste treatment technology	---	SA-82-001
SPAIN				
N Gerstein (DOE)	ENUSA, Nuclear Energy Board (May 1982)	Discuss potential Spanish participation in TMI cleanup	---	FR-82-007
AB Johnson (PNL) OP Gormley (DOE)	JEN (Spain) (May 1982)	Review Spanish waste management programs and technology; discuss potential cooperation	---	SP-82-001

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
SWEDEN				
DE Knowlton (PNL)	Ringhals, Studsvik (October 1981)	Tour cement solidification facilities at Ringhals; review Studsvik R/D programs	---	FR-82-006
N Gerstein (DOE)	Swedish Nuclear Power Inspectorate (May 1982)	Discuss potential Swedish participation in TMI cleanup	---	FR-82-007
AA Bauer (ONI)	Studsvik, KBS, Stripa (April 1982)	Review Studsvik waste management R/D; review status of NEA in situ tests at Stripa Mine	Yes	GW-82-031
AB Johnson (PNL)	KBS, Studsvik, Univ. of Stockholm (May 1982)	Discuss spent fuel storage	---	SP-82-001
GL McVay (PNL) A Ogard (LANL)	Studsvik (October 21-23, 1981)	Participate in Swedish-Canadian-US workshop on spent fuel disposal	---	SW-82-001
CJ Airola (Studsvik)	PNL (November 30, 1981)	Review US technology--LLW conditioning, MCC	---	SW-82-002
9-member Swedish team sponsored by SKBF/KBS	Rockwell-Hanford (April 5-6, 1982)	Review Rockwell basalt waste operations	---	SW-82-003
DE Gordon, GG Wicks (SRL)	Studsvik, Stripa Mine (June 1982)	Discuss cooperative tests at Stripa; review Swedish waste isolation program	Yes	SW-82-004
A Ogard (LANL) GL McVay (PNL)	Studsvik (September 1982)	Attend spent fuel disposal workshop	Yes	SW-82-005

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
SWEDEN (contd)				
US waste isolation team (8) from DOE, LANL, ONWI, PNL, USGS	KBS, Stripa Mine (October 1981)	Tour the Stripa Mine in situ test project	---	UK-82-003
SWITZERLAND				
N Gerstein (DOE)	Bernese Power Company, EIR (May 1982)	Discuss potential Swiss participation in TMI cleanup	---	FR-82-007
DJ Isherwood (LLNL)	Underground Research Facility at Grimsel, Institute for Reactor Research, Baden (October 1981)	Review Swiss repository program	---	SZ-82-001
Dr G Bart (EIR, Würenlingen	PNL (February 1, 1982)	Technical discussions on high-level waste package design, quality control, characterization	---	SZ-82-002
TAIWAN (REPUBLIC OF CHINA)				
Chou Tise-Cheng, Fu Ying-kai (INER)	PNL, ORNL (October 1981)	Review US waste management programs	---	TA-82-001

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
UNITED KINGDOM				
JD Sease, JE Vath (ORNL)	AEA-Harwell (October 1981)	Review Harwell waste treatment operations and R&D	---	BE-82-003
GL Tingey (PNL)	Harwell (June 1982)	Technical discussions--krypton immobilization	---	CEC-82-001
DA Waite (ONWI)	NRPB (October 1981)	Technical exchange--environmental transport and dose calculation methodologies	---	FR-82-003
N Gerstein (DOE)	UKAEA (May 1982)	Discuss potential UK participation in TMI cleanup	---	FR-82-005
DE Knowlton (PNL)	CEGB (October 1981)	Discuss TMI waste management R&D	---	FR-82-006
AB Johnson, Jr (PNL)	Bournemouth, Berkeley Laboratory, CEGB (October 1981)	Present paper at British Nuclear Society Conference on Water Chemistry in Nuclear Reactors (expenses paid by EPRI); technical exchange--spent fuel storage	---	SP-82-001
LL Burger (PNL)	AERE-Harwell (October 5-6, 1981)	Technical exchange--airborne waste management	---	UK-81-025
EJ Varney (Nuclear Installations Inspectorate	ONWI, AGNS, Barnwell, INEL, Rockwell-Rocky Flats, Rockwell-Hanford, PNL (October 5-20, 1981)	Review of US waste management practices and programs	---	UK-82-001

BILATERAL EXCHANGES

Visitor/Site	Site Visited/Date	Purpose of Visit	Visit Covered by Exchange Agreement	PNL File Number
UNITED KINGDOM (contd)				
E Christensen, D Christensen, T Short, J Anderson (LANL)	Aldermaston, AERE-Harwell (October 1981)	Technical exchange--waste treatment chemistry; waste incineration	Yes	UK-82-002
BR Erdahl (LANL)	Institute of Geo. Sciences, AERE-Harwell (October 1981)	Review UK geochemistry and hydrology studies	---	UK-82-003
DW Clelland (BNFL) N Keen (AERE-Harwell)	PNL (April 23, 1982)	Technical discussions--PNL waste management R&D programs	---	UK-82-004
AR Robinson (Harvard University; SNL consultant)	MAFF (UK), Institut de Mechanique (France) DHI (FRG) (January 1982)	Develop plans for intercomparison of ocean circulation models used by the US, UK, FRG and France	---	UK-82-005
UK team (9) from Risley, Dounreay, Aldermaston	Albuquerque (May 1982)	Participate in US-UK workshop on the Design of Size Reduction and Sorting Facilities	Yes	UK-82-006
MJ Lawrence, WH McVey, RL Philippone (DOE) WD Burch (ORNL)	Springfields, Risley (November 1981)	Attend annual meeting of the Ad Hoc Fuel Cycle Steering Committee under the US DOE/UKAEA LMFBR exchange	Yes	UK-82-007
CS Abrams (ANL West) BD Shipp (DOE)	Dounreay (June 1982)	Discuss US/UK Cooperation in the field of sodium waste material cleanup and disposal	Yes	UK-82-008

INTERNATIONAL SYMPOSIA AND CONFERENCES

Sponsor	Activity	U.S. Participants	PNL File Number
FUEL CYCLES			
	Jahrestagung Kerntechnik Conference (Mannheim; May 4-6, 1982)	ND Holder (General Atomic)	GW-82-035
	European Nuclear Society Conference (Brussels; April 26-30, 1982)		SP-82-001
	International Conference on Fast Reactor Fuel Cycles (London; November 9-12, 1981)	WD Burch, WH McVey, RL Philippone (DOE)	UK-82-007
WASTE MANAGEMENT			
HMI, MRS	Fifth International Symposium on the Scientific Basis for Radioactive Waste Management (Berlin; June 7-10, 1982)	29 US, 29 papers	INTL-82-006
WASTE TREATMENT			
IAEA, OECD, CEC	International Symposium on Conditioning of Radioactive Wastes for Storage and Disposal (Utrecht; June 21-25, 1982)		BE-82-004
IAEA	IAEA Seminar on the Management of Radioactive Wastes at Nuclear Power Plants (Karlsruhe, FRG; October 5-9, 1981)	15 US (DOE and DOE contractors - 8)	GW-81-054

INTERNATIONAL SYMPOSIA AND CONFERENCES (contd)

Sponsor	Activity	U.S. Participants	PNL File Number
GEOLOGIC WASTE ISOLATION			
	International Soil Sciences Conference (New Delhi, India; February 7-15, 1982)	D Rai (PNL)	INTL-82-004
	Third International Symposium organized by the Institution of Mining and Metallurgy, UK (Brighton, England; June 7-11, 1982)	HW Brandt (RHO)	INTL-82-008
ENVIRONMENTAL SAFETY AND RADIOLOGICAL PROTECTION			
IAEA	Symposium on the Application of the International Commission on Radiological Protection Dose Limitation System (ICRP-26) in Nuclear Fuel Cycle Facilities (Madrid; October 19-23, 1981)	DA Waite (ONWI)	FR-82-003
International Association on Water Pollution Research	Eleventh Conference of the International Association on Water Pollution Research (Capetown, South Africa; April 1982)	J Sivinski (CH_2M Hill)	INTL-82-003
NUCLEAR POWER			
IAEA	International Conference on Nuclear Power Experience (Vienna; September 13-17, 1982)		IAEA-82-010

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS

Sponsor	Activity	PNL File Number
SPENT FUEL STORAGE		
NEA	AS Johnson, Jr. (PNL) and OP Gormley (DOE) participated in an NEA specialists workshop on Techniques for the Dry Storage of Spent Fuel Elements (Madrid, Spain; May 11-13, 1982)	SP-82-001
SPENT FUEL REPROCESSING		
IAEA	HT Kerr (ORNL) participated in the third meeting of the IAEA Coordinated Research Programme on the "Use of Installed Instrumentation in Irradiated Fuel Reprocessing Facilities for Safeguards Purposes" (Vienna; November 30-December 4, 1981)	IAEA-82-009
WASTE TREATMENT		
CEC	GL Tingey (PNL) and MJ Stephenson (ORNL) attended the CEC Specialists Meeting on Methods of Kr-85 Management (Brussels; June 29, 1982)	CEC-82-001
IAEA	TR Thomas (ENICO) participated in an IAEA workshop to draft a document entitled "Testing and In-Plant Monitoring of Offgas Cleaning Systems at Nuclear Facilities" (Vienna; November 23-27, 1981)	IAEA-82-001
IAEA	LT Lakey (PNL) participated in the IAEA Technical Committee Meeting on the Treatment of Low- and Intermediate-Level Radioactive Liquid Waste (Piestany, Czechoslovakia; November 9-13, 1981)	IAEA-82-002

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS (contd)

Sponsor	Activity	PNL File Number
IAEA	J McBride (E.R. Johnson Associates) and RW McKee (PNL) represented the US as participants in an IAEA Technical Committee on Interim Storage of and Techniques for Handling Conditioned High-Level Waste (Bombay, India; December 7-11, 1981)	IAEA-82-003
IAEA	JL McElroy (PNL) participated in an IAEA Advisory Group meeting to review and revise a draft document, "Conditioning to Radioactive Waste for Storage and Disposal: Guidance for the Development of Waste Acceptance Criteria" (Vienna; August 23-27, 1982)	IT-82-001
MATERIALS CHARACTERIZATION		
ISO	JE Mendel attended a meeting of the ISO Working Group on Standardization of Measurement Methods for the Characterization of Solid and Solidified Waste Forms and for the Corrosion of Primary Containers (West Berlin; June 1982)	INTL-82-007
DECONTAMINATION AND DECOMMISSIONING		
IAEA	RI Smith (PNL) served as a consultant to the IAEA in helping to prepare a report on D&D technology (Vienna; September 26-October 10, 1981)	IAEA-81-006
IAEA	RI Smith participated in a committee of experts to review and revise a working draft report on techniques for decontamination and decommissioning of retired nuclear facilities; following the meeting he was retained by the IAEA to incorporate the committee's changes (Vienna; April 16-28, 1982)	IAEA-82-006

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS (contd)

Sponsor	Activity	PNL File Number
GEOLOGIC WASTE ISOLATION		
IAEA	JR McDowell assisted the IAEA as a consultant in preparing the draft of an IAEA report on analysis of the performance requirements of waste isolation systems (Vienna; March 15-18, 1982)	IAEA-82-004
IAEA	J Wiley (SRL) participated in Advisory Group and Consultants' meetings to revise an IAEA document on shallow-land burial in Vienna (March 1982) and at SRL (April 1982)	IAEA-82-005
IAEA	EL Albenesius (SRL) assisted the IAEA as a consultant in drafting and revising two documents dealing with safety analysis, design, construction and operation of shallow ground repositories (Vienna; October 1981)	IAEA-82-008
INTRACOIN	Five US participants (PNL, ONWI, ORNL, Intera) met with specialists from Sweden, Israel, Switzerland, FRG, France, UK, Canada and Finland in a four-day workshop in the field of radionuclide transport modeling. The workshop was an activity of the International Nuclide Transport Code Intercomparison Study (INTRACOIN) (February 14-19, 1982)	INTL-82-002
NEA	DR Anderson attended the first meeting of the Ad Hoc Legal and Institutional Task Group of the NEA Seabed Working Group (Paris; February 9-10, 1982)	NEA-82-004
NEA	6 US delegates participated in an OECD/NEA "Workshop on Geochemistry and Radioactive Waste Disposal" (Paris; May 24-26, 1982)	NEA-82-005

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS (contd)

Sponsor	Activity	PNL File Number
NEA	CR Cooley (DOE), WE Newcomb (ONWI) and JB Robertson (USGS) participated in a meeting of the Coordinating Group on Geologic Disposal (NEA) (Paris; October 7-8, 1981)	NEA-82-002
NEA	A technical committee meeting to review the ISIRS project was held at PNL, Richland, WA, June 8-11, 1982	NEA-82-006
NEA	DR Anderson (SNL) attended meetings of the Site Task Group (London) and the Coordinating Group (Paris) of the NEA Seabed Working Group. He also worked with the CEC Ispra Center in developing their five-year program for seabed R&D (May 1-7, 1982)	NEA-82-008
NEA	Paul Gnirk (RE/Spec) participated in an ad hoc meeting to discuss research objectives in Phase II of the Stripa Project (Paris; February 1982)	---
NEA	JL Ratigan (RE/Spec) participated in an ad hoc meeting to define the research programme in Phase II of the NEA Stripa Project (Paris; May 1982)	---
MARINE DISPOSAL		
UNESCO and Others	WL Templeton (PNL) participated in a technical committee meeting, sponsored by the Group of Experts on Scientific Aspects of Marine Pollution (GESAMP), to complete a GESAMP report, "Review of the Health of the Oceans" (Geneva; October 19-21, 1981)	INTL-82-001
IAEA/GESAMP	MG Marietta (SNL) attended the Third IAEA/GESAMP Working Group Meeting on "Oceanographic Dispersion Model for Wastes Disposal in the Deep Sea" (February 14-19, 1982)	INTL-82-005

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS (contd)

Sponsor	Activity	PNL File Number
NEA	WL Templeton (PNL) and V Noshkin (LLNL) participated in the first joint meeting of the Research Task Groups (Physical Oceanography, Geochemistry, Biology, Model Development and Radiological Surveillance) of the NEA Executive Group for Research on Sea Disposal of Radioactive Waste. The meeting was held at the MAFF Directorate of Fisheries, Lowestoft. Forty persons attended, representing 11 countries, IAEA and NEA (UK; April 21-22, 1982)	NEA-82-007
NEA	WL Templeton (PNL) and R Johnston (EPA) participated in the second meeting of te OECD-NEA Executive Group for Research on Sea Disposal of Radioactive Waste (Paris; September 1982)	NEA-82-009
URANIUM MILL TAILINGS		
IAEA	GW Gee and ML Marple participated in the first meeting of the IAEA Cooperative Research Programme on "Environmental Migration of Radium and Other Contaminants" (Ottawa, Canada; May 1982)	IAEA-82-007
GEOLOGIC DISPOSAL		
NEA	AR Robinson (Harvard Univ.) participated in a Seabed Working Group subcommittee meeting on circulation modeling for seabed disposal of nuclear wastes (Cambridge, UK; August 1982)	NEA-82-010
NEA	Eight US representatives (ONI, USGS, RHO) participated in the NEA workshop on "Geophysical Investigations in Connection with Geologic Disposal of Radioactive Waste" (Ottawa; September 1982)	NEA-82-011

INTERNATIONAL WORKSHOPS, TECHNICAL COMMITTEES AND GROUPS OF EXPERTS (contd)

Sponsor	Activity	PNL File Number
NEA	MG Marietta (SNL) participated in an interim meeting of the Systems Analysis Task Group of the International Seabed Working Group (Baden, Switzerland; September 1982)	NEA-82-012

DISTRIBUTION

No. of Copies

OFFSITE

DOE HEADQUARTERS

Office of Nuclear
Nonproliferation Policy
U.S. Department of Energy
IA-21, Forrestal
Washington, DC 20585
ATTN: J. Ebetino, Acting Deputy

Office of International Affairs
U.S. Department of Energy
IA-22, Forrestal
Washington, DC 20585
ATTN: H. Jaffe

4 Office of Defense Waste
and Byproducts Management
U.S. Department of Energy
GTN
Washington, DC 20545
ATTN: J. E. Dieckhoner
J. J. Jicha, DP-123
G. K. Oertel, DP-12
R. Scott, DP-121

Office of Nuclear Energy
U.S. Department of Energy
NE-2, Forrestal
Washington, D.C. 20585
ATTN: T. A. Dillon

Office of Support Programs
U.S. Department of Energy
NE-70, Forrestal
Washington, DC 20585
ATTN: S. Rosen

Office of Support Programs
U.S. Department of Energy
NE-75, GTN
Washington, DC 20545
ATTN: W. W. Henoch

No. of Copies

General Council Office
U.S. Department of Energy
GC-32, Forrestal
Washington, DC 20585
ATTN: S. K. Kuznick

Office of Converter Reactor
Development
U.S. Department of Energy
NE-10, GTN
Washington, DC 20545
ATTN: J. D. Griffith

32 Office of Terminal Waste
Disposal and Remedial Action
U.S. Department of Energy
GTN
Washington, DC 20545
ATTN: W. W. Ballard, Jr., NE-22
J. Baublitz, NE-24
F. E. Coffman, NE-20
J. R. Coleman, NE-25
C. R. Cooley, NE-22
C. H. George, NE-22
M. J. Lawrence, NE-34
A. F. Perge, NE-20 (25)

5 Office of Spent Fuel Management
and Reprocessing Systems
U.S. Department of Energy
GTN
Washington, DC 20545
ATTN: C. Bastin, NE-34
R. B. Chitwood
K. A. Klein
J. A. Leary, NE-44
K. O. Laughon
W. H. McVey

No. of Copies

DOE OPERATIONS OFFICES

5 Albuquerque Operations Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, NM 87115
ATTN: D. G. Boyer
K. Carlson
R. Y. Lowrey
J. McGough
D. T. Schueler

2 Chicago Operations Office
U.S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439
ATTN: R. H. Bauer, Manager
S. A. Mann

National Waste Program Office
U.S. Department of Energy
505 King Avenue
Columbus, OH 43201
ATTN: J. O. Neff

Idaho Operations Office
U.S. Department of Energy
550 Second Street
Idaho Falls, ID 83401
ATTN: J. B. Whitsett

2 Nevada Operations Office
U.S. Department of Energy
P.O. Box 14100
Las Vegas, NV 89114
ATTN: R. G. Romatowski, Manager
R. M. Nelson

2 Oak Ridge Operations Office
U.S. Department of Energy
P.O. Box E
Oak Ridge, TN 37830
ATTN: D. E. Large
R. Philippone

No. of Copies

San Francisco Operations Office
U.S. Department of Energy
1333 Broadway, Wells Fargo Bldg.
Oakland, CA 94612
ATTN: L. Lanni

3 Savannah River Operations Office
U.S. Department of Energy
P.O. Box A
Aiken, SC 29801
ATTN: F. H. Allhoff
T. B. Hindman
B. Wilson

2 DOE Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

CONTRACTORS

2 Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
ATTN: J. H. Kittel
M. J. Steindler

Argonne National Laboratory
P.O. Box 2528
Idaho Falls, ID 83401
ATTN: C. S. Abrams

4 Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201
ATTN: F. Djahanguiri
M. J. Golis
R. J. Hall
B. Rawles

Battelle
Human Affairs Research Centers
4000 NE 41st Street
Seattle, WA 98105
ATTN: A. H. Schilling

No. of Copies

Brookhaven National Laboratory
Upton, NY 11973
ATTN: P. W. Levy

EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415
ATTN: G. B. Levin

Exxon Nuclear Idaho Company, Inc.
P.O. Box 2800, WCB-S1
1955 Fremont
Idaho Falls, ID 83401
ATTN: R. A. Brown

Lawrence Berkeley Laboratory
Berkeley, CA 94720
ATTN: P. A. Witherspoon

2 Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550
ATTN: R. E. Batzel, Director
F. Holzer

2 Los Alamos National Laboratory
P.O. Box 1663
Los Alamos, NM 87544
ATTN: L. Borduin, MS-517
D. T. Oakley, MS 671

Mound Facility
Monsanto Research Corporation
P.O. Box 32
Miamisburg, OH 45342
ATTN: M. L. Rogers

4 Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, TN 37830
ATTN: J. O. Blomeke
W. D. Burch
L. J. Mezga
T. H. Row

No. of Copies

Rocky Flats Plant
Atomics International Division
Rockwell International
P.O. Box 464
Golden, CO 80401
ATTN: W. S. Bennett

3 Sandia Laboratories
P.O. Box 5800
Albuquerque, NM 87185
ATTN: R. M. Jefferson
R. W. Lynch
W. D. Weart

2 Savannah River Laboratory
Aiken, SC 29808
ATTN: J. L. Crandall
A. S. Jennings

Westinghouse Electric Corporation
P.O. Box 10864
Pittsburgh, PA 15236
ATTN: J. H. Saling

Westinghouse Electric Corporation
Advanced Energy Systems Division
WIPP Library, Box 40039
Albuquerque, NM 87196
ATTN: R. K. Brown

West Valley Nuclear Services, Inc.
P.O. Box 191
West Valley, NY 14171
ATTN: J. L. Knabenshuh

West Valley Demonstration Project Office
U.S. Department of Energy
P.O. Box 191
West Valley, NY 14171
ATTN: W. Hannum

No. of Copies

OTHER GOVERNMENT AGENCIES

2 Office of Radiation Programs
Environmental Protection Agency
MS ANR-461
401-M S.W.
Washington, DC 20460
ATTN: B. R. Dyer
G. L. Sjoblom

FOREIGN

Waste Management Section
Division of Nuclear Fuel Cycle
International Atomic Energy Agency
Wagramerstrasse 5, P.O. Box 100
A-1400, Vienna
Austria
ATTN: A. Hagen

ONSITE

5 DOE Richland Operations Office

P. F. X. Dunigan, Jr. (2)
R. W. Newlin
J. J. Schreiber
J. D. White

4 HEDL - Westinghouse

C. R. Allen
A. G. Blasewitz
R. E. Lerch
J. D. Watrous

No. of Copies

23 Pacific Northwest Laboratory

T. D. Chikalla
J. M. Davidson
F. H. Dove
K. M. Harmon (5)
A. B. Johnson, Jr.
L. T. Lakey
R. C. Liikala
J. L. McElroy
J. E. Mendel
D. A. Shields
Publishing Coordination (2)
Technical Information Files (5)

Rockwell-Hanford Operations

C. L. Brown
J. L. Deichman

UNC Nuclear Industries

W. J. Kyriazis