MEMORANDUM FOR: Ronald Ballard, Chief
Geosciences and Systems Performance Branch

FROM: Philip S. Justus, Section Leader
Geology-Geophysics Section
Geosciences and Systems Performance Branch

SUBJECT: TRIP REPORT - 1989 JOINT INTERNATIONAL (RADIOACTIVE) WASTE MANAGEMENT CONFERENCE AND TRIP TO URANIUM MINE, KYOTO, JAPAN 22-26 OCTOBER 1989

The Joint International (Radioactive) Waste Management Conference that I attended as discussed below was one of several held around the world in 1989. The NRC is represented at most of them. As the only NRC representative at this meeting I felt an especially strong obligation to make NRC's presence known. Therefore, I attended as many functions as I could and engaged as many people from as many countries as I could. One of the highlights of this effort was to engage the Russian delegation in conversation and to attempt to facilitate their interaction with the DOE representatives.

Title: Joint International Waste Management Conference

Date/Place: 22-26 October 1989 Kyoto, Japan

Agenda: See Enclosure 1, Final Program

Attendees: See Enclosure 2, Preliminary List of Attendees

Sponsors: American Society of Mechanical Engineers, Japan Society of Mechanical Engineers, IAEA Co-op

Co-sponsors: American Nuclear Society, Canadian Nuclear Society, Chinese Nuclear Society, European Nuclear Society, Hong Kong Institution of Engineers, Korean Nuclear Society, Nuclear Energy Society of Taiwan

Purpose: Participate in the Conference. Attend sessions on International radioactive waste management activities, HLW processes and disposal systems and HLW performance assessment and tests. Observe and review Shizuhara underground test facility and natural analog studies of radionuclide migration in geologic setting (uranium ore deposit), and Shomasama Test Field where ground-water hydrology is studied in deep wells.

Discussion: The purpose of the trip was fulfilled, as I attended the relevant HLW sessions and the excursion to the Tono uranium mine being used as an in situ test facility and natural analog of radionuclide migration in saturated rocks. I will highlight

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some of my observations. The DOE leadoff presentation by L. Duffy was made by S. Rousso. The written record of that talk is enclosed in this report (Enclosure 3), because it was not submitted in time to be printed in the official proceedings. Incidentally, the proceedings include written submittals covering HLW, LLW and ILW (intermediate-level radioactive waste). The proceedings volumes are available in my office. An expeditious way for me to share the information presented is to circulate the tables of contents (Enclosure 4). Mr. Rousso freely admitted that DOE had made mistakes regarding radioactive waste disposal at its defense waste facilities and that past practices were not adequate to protect public health and safety. DOE is about to embark on a 30-year aggressive program to rectify past actions. There is a major effort underway in DOE to change focus from production to protection. DOE pledges to administer a program outlined in its "Environmental Restoration and Waste Management 5-year Plan" as follows: contain spilled waste; develop required technology; support establishment of new compliance agreements and develop a risk-based system clean-up plan.

The delegation from the USSR was apparently the first at such a Conference to express a desire to actively cooperate with other nations to learn from successes and failures of past actions. They expressed a willingness to share lessons learned and to show visitors various waste sites in the Soviet Union. They desire to observe similar activities in other countries. I found out that they were expecting an invitation from DOE to visit US facilities. I attempted to locate reps from DOE and discovered that DOE reps left after the first day. I'll pursue this matter with our IP staff.

EPA's Floyd Galpin discussed his agency's activities in HLW, LLW, mill tailings and ocean disposal. In HLW he emphasized ways EPA is trying to assure that the standards will be met: 1) institutional controls for not more than 100 years (used Love Canal example); 2) monitor performance for reasonable time; 3) keep records; 4) multi-barriers; 5) avoid sites with resources; 5) recoverability for reasonable time (when questioned, he said 100's of years is reasonable). See Enclosure 5 for Galpin and others' paper.

Prof. L. Shemilt of the Technical Advisory Committee to the Atomic Energy of Canada Limited (TAC) is a waste management sage. I recommend that he be invited to NRC to share his wisdom on peer review and deterministic vs probabilistic methods of analysis. I discovered that he was unaware of the Technical Review Board, a body with similar responsibilities to the TAC. I will be introducing him to the TRB's Executive Director,

W. Coons, as per my conversation with Mr. Coons. See Shemilt and Sheng's paper in Conf. Proc., v. 2, pp. 403-410.

The field trip to the Tono uranium mine did not reveal new ideas on in situ testing or natural analogs of radionuclide transport in the saturated zone. However, the results of studies from the tests conducted at this facility should prove of value to DOE inasmuch as the efficacy of various methods of measuring and evaluating flow and transport in the saturated, fractured sedimentary rock environment at Tono are or may be a basis of comparison or calibration of techniques that it might use. The guidebook to Tono is available in my office. Selected portions are enclosed for your handy reference (Enclosure 6).

Deep geologic disposal of HLW seems to now be a universal quest, based upon the recurrence of that goal in most countries' presentations. Only Taiwan pushed hard for subseabed disposal. However, there appeared to be some sentiment for subseabed disposal.

Public acceptance of radioactive waste disposal was another recurrent theme. All countries apparently acknowledge that negative public attitudes need to be addressed squarely, such as by educational programs. However, few such programs were specific. See Numark and Wonder, Conf. Proc., v. 2, 389-397.

Part 60 concepts and various USA waste management activities seem to have taken root in Japan and People's Republic of China, among other countries. Multi-barrier concept, performance assessment by computer modeling, natural analog studies, vitrification are all accepted. It is no surprise that because all sites in Japan are saturated and geologically complex, the Japanese emphasize the engineered barrier in their multi-barrier system.

Benefits: The benefits of this trip are accrued to NRC both tangibly, through this report, and intangibly by 'making a presence' at the Conference, such that representatives from various organizations learned about NRC by asking me about our structure and activities. Similarly, through my questioning of other participants, I learned about approaches being taken by other countries to manage their waste. As a future investment, NRC can be better represented in dealing with visitors when its staff has knowledge of the visitors' operations, approaches to waste management and rapport derived from previous contacts. The knowledge I gained from people and from the visit to the Tono mine analog has the potential for making me a more useful NRC technical manager than I was prior to the Conference. The specific reference materials that I brought back have already

proven useful to Mr. Browning as background for his NEA trip. The international community appears eager to hear from NRC about our regulatory experiences and lessons learned. I encourage those who read this report to facilitate NRC staff participation in the agenda of the international waste management community. There are many more mutual benefits of sharing information and experiences than I can enumerate here.

/s/

Philip S. Justus, Section Leader
Geology-Geophysics Section
Geosciences and Systems Performance Branch

Enclosures: in binder on shelf
1. Agenda
2. Attendees
3. DOE's preprint
4. Contents of the Proceedings
5. EPA's preprint
6. Field Trip Guide Excerpts

DISTRIBUTION:

Central Files	HLGP r/f	NMSS r/f
RBrowning, HLWM	BJYoungblood, HLWM	JBunting, HLEN
RBallard, HLGP	JLinehan, HLPD	DChery, HLGP
PJustus, HLGP	SCoplan, HLGP	RJohnson, HLPD
JKennedy, HLPD	RWeller, HLEN	MNataraja, HLEN
JCorrado, HLPD	JGreeves, LLW	JRussell, CNWRA
HSchechter, IP		

OFC : HLGP	: HLGP	: HLGP	:	:	:
NAME: PJustus:ga	:	:	:	:	:
Date: 01/26/90	: / /90	: / /90	: / /90	: / /90	: / /90

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Enclosure 1
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DAILY SCHEDULE

DAY	AM	PM	
Sunday October 22		3:00-6:00 Registration (Miyako)	6:00-8:00 Welcome Reception (Miyako)
Monday October 23	8:00-9:30 Registration (KICH) 9:30-12:30 Plenary Session	2:00-5:20 Technical Sessions	
		9:00am-5:00pm Exhibition	
Tuesday October 24	9:00-12:20 Technical Sessions & Posters	2:00-5:20 Technical Sessions & Posters	
		9:00am-5:00pm Exhibition	
Wednesday October 25	9:00-12:20 Technical Sessions	2:00-4:00 Technical Sessions	
		9:00am-2:00pm Exhibition	
Thursday October 26		8:00am-6:00pm ASME Short Course—Part I (Holiday Inn)	
		*am-pm Technical Tour No. 1 (Mihama)	
		*am-pm Technical Tour No. 2 (Tono)	
Friday October 27		8:30am-6:00pm ASME Short Course—Part II	
Saturday October 28		8:30am-12:30pm ASME Short Course—Part III	

*Exact time to be announced

TECHNICAL SESSIONS

OPENING SESSION 1

Monday, 9:30 AM-12:30 PM Room A

INTERNATIONAL UPDATE ON RADIOACTIVE WASTE MANAGEMENT ACTIVITIES

Opening Address: RADOVAN KOHOUT, Conference General Chairman, Ontario Hydro, Toronto, Ontario, CANADA

Welcome Address: MICHIO ISHIKAWA, Conference General Co-Chairman, Japan Atomic Energy Research Institute, Tokaimura, JAPAN

YUTAKA YAMAMOTO, Honorable General Chairman, Institute of Applied Energy, Tokyo, JAPAN

Co-Chairman: R. KOHOUT, Ontario Hydro, Toronto, Ontario, CANADA

Co-Chairman: A. SUZUKI, University of Tokyo, Tokyo, JAPAN

1. Overview of the U.S. Radioactive Waste Management Activities SAM ROUSSO
~~L. P. DUFFY~~, U.S. Department of Energy, Washington, DC, U.S.A.

2. Management of Radioactive Waste in Chinese Nuclear Industry
PAN ZIQIANG, MAO HUANZHANG, LI XUEQUN, CHEN SHI, China Nuclear Industry Corporation, Beijing, CHINA

3. Policy of Japan Radioactive Waste Management
A. OYAMA, Commissioner, Japan Atomic Energy Commission, Tokyo, JAPAN

4. Radioactive Waste Management in Western Europe
F. H. PASSANT, International Union of Producers and Distributors of Electrical Energy (UNIPEDE)

5. Policy and Principles of Radioactive Waste Management in U.S.S.R.
A. SCNIKIFOROV and B. V. NIKIPELOV, State Committee for Utilization of Atomic Energy, Moscow, U.S.S.R.

SESSION 2

Monday, 2:00 PM-5:20 PM Room B-1

INTERNATIONAL HLW VITRIFICATION TECHNOLOGY

Chairman: M. YAMAMOTO, PNC, Tokyo, JAPAN

Co-Chairman: W. HEAFIELD, British Nuclear Fuels plc, Risley, Warrington, UNITED KINGDOM

Co-Chairman: T. W. McINTOSH, NE-24, U.S. Department of Energy, Washington, DC, U.S.A.

1. Glass Melter and Process Development for the PNC Tokai Vitrification Facility
S. TORATA, M. YOSHIOKA, T. TAKAHASHI, M. HORIE and H. IGARASHI, Power Reactor and Nuclear Fuel Development Corporation, JAPAN

(continued)

SESSION 2 (continued)

2. Application of Scaled LFCM Mock-Up Test to Commercial Scale Vitrification
A. SAKAI, N. SUGIURA, N. TERANISHI, Y. OHUCHI and H. SAIGA, Ishikawajima Harima Heavy Industries, Tokyo, JAPAN

3. Overall and Single-State Decontamination Factors During the 1985-87 HLW Vitrification Campaigns in the PAMELA
F. BAUMGÄRTNER and K. KREBS, Tech. University, Munich, and O. PETZOLDT, Lurgie GmbH, FEDERAL REPUBLIC OF GERMANY

4. Special Equipment for Nuclear Applications in the Back End of the Fuel Cycle
M. LUNG, F. X. DOUCET, M. CREISSELS, and Y. BEROUD, Société Général pour les Techniques Nouvelles, (SGN), FRANCE

5. Application of Power Fluidics in British Nuclear Reprocessing Plants
H. M. SHAW, British Nuclear Fuels, UNITED KINGDOM

6. Hanford Waste Vitrification Plant Technology Progress
B. A. WOLFE, Westinghouse Hanford Company, Richland, WA, and C. R. ALLEN, Battelle, Pacific Northwest Laboratory, U.S.A.

7. Technical and Project Highlights for the Defense Waste Processing Facility
J. B. MELLEN, T. H. BURKE and B. G. KITCHEN, Westinghouse Savannah River Company, Aiken, SC, U.S.A.

SESSION 3

Monday, 2:00 PM-5:20 PM Room B-2

LOW/INTERMEDIATE WASTE PROCESSING EXPERIENCE

Chairman: T. HILLMER, Arizona Nuclear Power Projects, Phoenix, AZ, U.S.A.

Co-Chairman: Z. MIN, Beijing Institute of Nuclear Engineering, Beijing, CHINA

Co-Chairman: R. SJOBLOM, National Board for Spent Fuel, (SKN), Stockholm, SWEDEN

1. Radioactive Waste Source Volume Reduction by Improving Water Chemistry Control of the Condensate Purification System in a BWR
C. AMANO and S. YOSHIKAWA, TEP Co., Ltd., K. OHSUMI, Hitachi Ltd., F. MIZUNIWA, H. SUZUKI and K. SUZUKI, Hitachi Kyowa Kogyo Co., Ltd., Ltd., N. USUI, and M. AIZAWA, Hitachi Engineering Co., Ltd., JAPAN

2. Ultrafiltration Treatment of Laundry Liquid Wastes From a Nuclear Research Center
BARNIER, Cadarache Nuclear Research Center, CAMINADE and LOUDENOT, Technicatome, MAUREL and COURTOIS, Cadarache Nuclear Research Center, FRANCE

3. Experience Achieved on Volume Reduction of Radioactive Waste and on Final Product Qualification
C. D'ANNA, A. AGOSTINELLI and P. DIGIUSEPPE, ENEL, Roma, ITALY

(continued)

SESSION 3 (continued)

4. Development of a Radioactive Spent Ion-Exchange Resin Treatment System
K. ANDO, Y. INAGAKI and H. MIYAMOTO, Mitsubishi Heavy Industries, Ltd., H. NISHIKAWA, Kanasi EP Co., Ltd., H. TAGA, HEP Co., Ltd., I. TSUJIMOTO, SEP Co., Ltd., M. KITAJIMA, Kyushu EP Co., Ltd., T. MORITA, The Japan Atomic Power Company, JAPAN

5. Significance of Chemotoxic Admixtures in Radioactive Wastes
E. R. MERZ, Kernforschungsanlage Jülich, FEDERAL REPUBLIC OF GERMANY

6. Recent Studies on Advanced for the Decontamination of Low and Intermediate Level Wastes
J. E. CROSS, E. W. HOOPER, Harwell Laboratory, Oxfordshire, UNITED KINGDOM

SESSION 4

Monday, 2:00 PM-5:20 PM Room C-1

TRANSPORTATION OF HLW AND SPENT FUEL

Chairman: L. H. HARMON, U.S. Department of Energy, Germantown, MD, U.S.A.

Co-Chairman: H. W. CURTIS, Nuclear Transport Ltd., Cheshire, UNITED KINGDOM

Co-Chairman: B. LENAIL, Cogema, Velizy-Villacoublau, FRANCE

Co-Chairman: T. TAMAI, Ishikawajima-Harima Heavy Industries Co., Tokyo, JAPAN

1. Systems for the Transportation of CANDU Irradiated Fuel by Road, Rail and Water
D. J. RIBBANS, Ontario Hydro, Toronto, CANADA

2. Transport of Radioactive Materials in the United States—An Integrated and Cooperative Effort
F. P. FALCI and S. H. DENNY, U.S. Department of Energy, Washington, DC, U.S.A.

3. Design and Fabrication of NKK Dry Transportation and Storage Cask
Y. HARADA and N. URABE, NKK Corp., JAPAN

4. The European Approach to the Transport of High-Level Waste
B. LENAIL, COGEMA, FRANCE and H. W. CURTIS, Nuclear Transport Limited, U.K.

5. An Innovative Approach to Spent Fuel Transportation Cask Design
B. R. NAIR, Westinghouse Electric Corporation, Pittsburgh, PA, U.S.A.

6. Transporting Spent and Damaged Fuel in the United States: Recent Experience and Lessons Learned Related to Evolving Transportation Policies of the U.S. Department of Energy
R. C. SCHMITT, EG&G Idaho, Inc., Idaho Falls, ID, and L. H. HARMON, U.S. DOE, Washington, DC, U.S.A.

7. Using Satellite Communications to Improve Public Relations in Radioactive Materials Transport
J. D. HURLEY, Westinghouse, c/o U.S. DOE, Washington, DC, U.S.A. and L. H. HARMON, U.S. DOE, Washington, DC, U.S.A.

SESSION 5

Monday, 2:00 PM–5:20 PM Room C-2

INCINERATION

Chairman: H. KURIBAYASHI, JGC Corporation, Tokyo, JAPAN

Co-Chairman: V. DE CRESCENZO, ENEA, Rome, ITALY

1. Performances of a Demonstrative Incineration Plant Designed for Homogeneous Waste Processing
G. SANDRELI, ENEL—Thermal and Nuclear Research Centre, Milano, S. TERRANI, Politecnico di Milano, S. SANGALLI, Societa Construzioni Speciali per L'Industria Nucleare, Milano, ITALY

2. Co-Incineration of Nuclear Plant Spent Resin with Combustible Solid Waste
K. MATSUMURA and O. AMANO, Tokyo Electric Power Co., S. MUTOH, K. YAMAMOTO and S. YASUI, NGK Insulators, Ltd., JAPAN

3. Latest Development of Waste Incineration in the Juelich Incineration Process
W. WURSTER, Kraftanlagen AG, Heidelberg, M. LASER, Juelich Nuclear Research Centre, Juelich, FEDERAL REPUBLIC OF GERMANY; and S. KAMADA, Mitsui Engineering & Shipbuilding Co., Tokyo, JAPAN

4. Catalytic Incineration of Ion Exchange Resins Using Fluidized Bed
T. YAHATA, K. KINOSHITA, M. HIRATA and M. KURIHARA, Japan Atomic Energy Research Institute, JAPAN

5. Recent Research in Incinerator Radioactive Smoke Filtration and Improvements in a TRU Waste Incineration Plant
S. CARPENTIER, SGN and C. DE TASSIGNY, CEA, Grenoble, FRANCE; Y. HASHIMATO and A. INOUE, Hitachi-Zosen Corp., JAPAN

6. Demonstration of Multi-Purpose Incinerating Melter System
Y. TANAKA, H. WAKUI, T. HADA and M. KAWAKAMI, Chiyoda Corp., JAPAN

7. Treatment of Spent Solvent By Submerged Combustion Process
G. UCHIYAMA, M. AMAKAWA, M. MAEDA and S. FUJINE, Japan Atomic Energy Research Institute, JAPAN

SESSION 6

Tuesday, 9:00 AM–12:20 NOON Room B-1

UPDATE ON INTERNATIONAL HLW MANAGEMENT TECHNOLOGIES

Chairman: K.-D. KUHN, DWK, Hannover, FEDERAL REPUBLIC OF GERMANY

Co-Chairman: T. ISHIHARA, Radioactive Waste Management Center, Tokyo, JAPAN

1. Overview of High-Level Radioactive Waste Management in Japan
T. TSUBOYA, S. MASUDA, S. SAITO, and Y. ASAKURA, Power Reactor and Nuclear Fuel Development Corporation (PNC), Akasaka, Minato-ku, JAPAN

(continued)

SESSION 6 (continued)

2. Vitrification of High-Level Waste in the FRG: Development and Operation of the PAMELA Process
K. D. KUHN and W. KUNZ, DWK, Hannover, FEDERAL REPUBLIC OF GERMANY, W. GRÜNEWALD, Karlsruhe Nuclear Research Center, FEDERAL REPUBLIC OF GERMANY

3. Slurry-Fed Ceramic Melter—A Broadly Accepted System to Vitrify High-Level Waste
C. C. CHAPMAN and J. L. McELROY, Battelle Pacific Northwest Laboratory, Richland, WA, U.S.A.

4. An Overview of Vitrification for High-Level Radioactive Waste in China
L. GUOMING and W. XIAN DE, Beijing Institute of Nuclear Engineering, Beijing, CHINA

5. The Italian R&D Activities in the Field of Treatment and Conditioning of "Third Category" (High-Level) Liquid Radioactive Wastes
P. VENDITTI and G. GROSSI, ENEA, Roma, ITALY

6. Vitrification of High-Level Waste in France: Over 30 years of Continuous Development from the Laboratory to Industrial Facilities
C. G. SOMBRET, CEA, D. ALEXANDRE, COGEMA; J. MAILLET, SGN, FRANCE

7. High-Level Waste Management in the United Kingdom
W. HEAFIELD and A. D. ELSDEN, British Nuclear Fuel plc, Cheshire, UNITED KINGDOM

SESSION 7

Tuesday, 9:00 AM–12:20 PM Room B-2

NATIONAL LOW/INTERMEDIATE LEVEL WASTE MANAGEMENT PROGRAMS

Chairman: E. H. PASSANT, Central Electricity Generating Board, Barnwood, UNITED KINGDOM

Co-Chairman: T. AMANUMA, Nuclear Safety Research Association, Tokyo, JAPAN

1. Low-/Intermediate-Level Waste Disposal in Switzerland
H. ISSLER and E. KOWALSKI, NAGRA, Baden, SWITZERLAND

2. Status and Development on Treatment of Low and Intermediate Level Radioactive Wastes in China
W. XIAN DE and S. M. SHENG, Beijing Institute of Nuclear Engineering, Beijing, CHINA

3. Radioactive Waste Management in the United Kingdom
R. H. FLOWERS, Atomic Energy Authority, Harwell, UNITED KINGDOM

4. The Dutch Treatment And Long-Term Storage Facility for Radioactive Wastes
H. D. K. CODEE and I. J. VRIJEN, COVRA, Petten, THE NETHERLANDS

5. Status of Low and Intermediate Level Radwaste Management in Korea
K. W. HAN and H. H. PARK, Korea Advanced Energy Research Institute, Choong-Nam, KOREA

(continued)

SESSION 7 (continued)

6. Status of Activities: LLR.W Management in the U.S.A.
C. B. OZAKI, R. C. SHILKETT, and T. D. KIRKPATRICK, EG&G Idaho, Inc., Idaho Falls, ID, U.S.A.

7. Radwaste Management in Taiwan, China
C.-M. TSAI and D.-P. CHOU, Atomic Energy Council, Taiwan, CHINA

SESSION 8

Tuesday, 9:00 AM–12:20 PM Room C-1

ACCEPTIBILITY OF HLW FORMS FOR DISPOSAL

Chairman: E. MERZ, Jülich Nuclear Research Center, Jülich, FEDERAL REPUBLIC OF GERMANY

Co-Chairman: J. M. PLODINEC, Westinghouse Savannah River Company, Aiken, SC, U.S.A.

Co-Chairman: H. AMANO, Nagoya University, Nagoya, JAPAN

1. Safety Examination of HLW Solidified Products at WASTEF
S. TASHIRO, T. BANBA, H. MITAMURA, H. KAMIZONO, S. KIKKAWA, S. MATSUMOTO, S. MURAOKA and H. NAKAMURA, Japan Atomic Energy Research Institute, Tokaimura, JAPAN

2. Research and Development to Handle Vitrified Waste to be Returned From Overseas Reprocessing Plants
Y. KATSUNUMA and S. MURAKOSHI, Radioactive Waste Management Center, Tokyo; T. YAMAMOTO and N. MITSUSHIMA, Kobe Steel, Ltd., Tokyo, JAPAN

3. Analytical Facility Design to Support Qualification of Vitrified High-Level Waste for Repository Acceptance
R. KEENAN, WasteChem Corp., Irvine, CA, U.S.A.; E. SCHULTES, NUKEM GmbH, FEDERAL REPUBLIC OF GERMANY

4. The Vitrification of HLLW, Process and Product Quality Studies by Means of a Lab Scale Liquid Fed Ceramic Melter
M. KELM, B. OSER, B. LUCKSCHEITER, W. BERNOTAT and H. PENTINGHAUS, Karlsruhe Nuclear Research Center, Karlsruhe, FEDERAL REPUBLIC OF GERMANY

5. The U.S. Environmental Protection Agency's Radioactive Waste Disposal Regulatory Activities
F. L. GALPIN, W. F. HOLCOMB, J. M. GRUHLKE and D. J. EGAN, Jr., U.S. Environmental Protection Agency, Washington, DC, U.S.A.

6. Establishing the Acceptibility of Savannah River Plant Waste Glass
M. J. PLODINEC, Westinghouse Savannah River Company, Aiken, SC, U.S.A.

7. Application of Stochastic Dynamic Simulation to Waste Form Qualification for the HWVP Vitrification Process
W. L. KUHN and J. H. WESTSIK, Jr., Battelle Pacific Northwest Laboratory, Richland, WA, U.S.A.

SESSION 9

Tuesday, 9:00 AM–12:20 PM Room C-2

RECENT LOW/INTERMEDIATE LEVEL WASTE MANAGEMENT TECHNOLOGIES

Chairman: E. McDANIEL, Martin Marietta Energy Systems, Oak Ridge, TN, U.S.A.

Co-Chairman: Y. NAKAYAMA, Nippon Atomic Industry Group Co., Kawasaki-ku, JAPAN

Co-Chairman: R. H. KRAEMER, Kernforschungszentrum Karlsruhe GmbH Karlsruhe, FEDERAL REPUBLIC OF GERMANY

1. Microbial Treatment of Radioactive Waste
E. H. TUSA, Imatran Voima Oy, Vantaa, FINLAND

2. Feasibility Testing of In-Situ Vitrification of Uranium-Contaminated Soils
H. IKUSE, S. TSUCHINO and H. TASAKA, Mitsubishi Metal Corp., Tokyo, JAPAN; C. L. TIMMERMAN, Battelle Memorial Institution, U.S.A.

3. Techniques of Treatment or Conditioning for Waste Arising from Iodine-131 Production
J. C. DELLAMANO, Comissao Nacional de Energia Nuclear, Sao Paulo, BRAZIL

4. An Alternative for Low-Level Waste Management During MOX Fuel Fabrication and Reprocessing in PNC
K. MIYATA, J. OHUCHI, E. INADA and N. TSUNODA, Power Reactor and Nuclear Fuel Development Corporation, JAPAN

5. Waste Disposal in Underground Caverns by In-Situ Solidification Technique
R. H. KRAEMER and R. H. KROEBEL, Kernforschungszentrum Karlsruhe GmbH., Karlsruhe, FEDERAL REPUBLIC OF GERMANY

6. Impedence Evaluation of Lining Material of LLW Canisters
T. P. CHENG, J. T. LEE and W. T. TSAI, National Cheng Kung University, Taiwan, CHINA

7. Field Tests for Safe and Reliable Inspection and Storage of Low Level Radioactive Wastes
R. YAMADA and T. IWASE, Radioactive Waste Management Center; T. OHMICHI, Mitsubishi Metal Corp., JAPAN

POSTER SESSION 10

Tuesday, 10:00 AM–12:20 PM Rooms G,H

SCIENCE OF HLW PROCESSES AND DISPOSAL

Chairman: K. HIRANO, Nuclear Safety Research Center, Tokai-Mura, Japan

Co-Chairman: S. MASUDA, PNC, Tokyo, JAPAN

1. Developments in Liquid-Liquid Extraction for Fuel Reprocessing Reduce Waste Management Problems
J. A. JENKINS, D. H. LOGSDAIL, E. LYALL, P. E. MYERS, B. A. PARTRIDGE and P. MISTRY, United Kingdom Atomic Energy Authority, Oxfordshire, UNITED KINGDOM

(continued)

2. A Method for Monitoring of Uranium Extraction Zone from Axial Temperature Profile in a Pulsed Column
T. TSUKADA and K. TAKAHASHI, Central Research Institute of Electric Power Industry, Tokyo, JAPAN

3. Pyrolysis of TBP Waste Synthetic Mica
S. NAGAHARA, Y. NAKAMORI, T. KUBOTA, Mitsui Engineering and Shipbuilding Co., Ltd., Tokyo, S. MURAYAMA, K. OCHIAI and T. TSUBOYA, Power Research and Nuclear Fuel Development Corporation, JAPAN

4. Similarity Analysis of Laminar Free Convection in Square Cavity Containing Heat Generating Kr-85 Gas
I. YAMAMOTO and A. KANAGAWA, Nagoya University, Nagoya, JAPAN

5. Estimation of Transient Performance of a Purex Solvent Extraction Cycle by Process Simulation Code 'DYNAC'
M. NABESHIMA and C. TANAKA, Sumitomo Metal Mining Co., Ltd., Tokai-mura, Ibaraki, JAPAN

6. Experimental Study on Decontamination of Volatile Ruthenium with Water Scrubbing
K. SHIRATO, M. KITAMURA, T. KANNO and T. MURAKOSHI, Ishikawajima Harima Heavy Industries (IHI) Co., Ltd., Tokyo, JAPAN

7. Fuel Reprocessing and Waste Management: How Does One Affect the Other
R. L. PHILIPPONE and R. A. KAISER, Bechtel National, Inc., Oak Ridge, TN, U.S.A.

8. Recovery and Utilization of Valuable Metals from Spent Nuclear Fuel
Y. WADA, K. KIRISIMA, K. WADA, K. KAWASE, and N. SASAO, Power Reactor and Nuclear Fuel Development Corporation, Tokai-mura, Ibaraki, JAPAN

9. The Development and Benefits of Plant Simulators for Waste and Spent Fuel Management
S. F. EVANS, M. FIDGETT and I. J. SMITH, British Nuclear Fuels plc, Cheshire, UNITED KINGDOM

10. Safety Cases for Nuclear Chemical Plants
W. J. BOWERS, British Nuclear Fuels plc, Cheshire, UNITED KINGDOM

11. Development of Dismantling Technology for Spent Melter
Y. OGATA, H. KOBAYASHI, T. TAKAHASHI and M. HORIE, Power Reactor and Nuclear Fuel Development Corporation, Tokai-mura, Ibaraki, JAPAN

12. Calculations of γ-Ray Transmutation for TRU Wastes
T. MATSUMOTO, Hokkaido University, Sapporo, JAPAN

13. Leach Rates of Lead-Iron Phosphate Waste Glasses
T. YANAGI, M. YOSHIZOE and K. KURAMOTO, Osaka University, Osaka, JAPAN

14. Interaction of Feed Rate, Waste Composition and Power Input in Electrically Heated HLW Glass Furnaces
J. KINNER, E. TITTMAN and F. HOLL, Kraftanlagen, Heidelberg, FEDERAL REPUBLIC OF GERMANY

15. A Study on the Needs and Economics of Spent Fuel Storage in Japan
K. NAGANO and K. YAMAJI, Central Research Institute of Electric Power Industry, Tokyo, JAPAN

16. Spent Fuel Storage Activities in Tokai Reprocessing Plant
N. SUYAMA, H. OKAMOTO and T. ONISHI, Power Reactor and Nuclear Fuel Development Corporation, JAPAN

(continued)

17. Conceptual Design of a High-Level Vitrified Waste Storage Facility
N. MACHIDA, Y. KATANO, Y. KAMIYA, Kumagai Gumi Co., Ltd., JAPAN and L. J. JARDINE and J. HOEKWATER, Bechtel National, Inc., U.S.A.

18. Conceptual Study on Interim Storage System to Utilize Waste Heat from Spent Fuel and High-Level Waste
M. ARITOMI, Tokyo Institute of Technology, Tokyo; M. WATARU, Central Research Institute of Electric Power Industry, Tokyo; and K. MATSUOKA, Tokyo Electric Power Co., Inc., Tokyo, JAPAN

19. Qualification of a Foundry as Manufacturer for Packagings Made of Modular Cast Iron
W. ANSPACH, NUKEM GmbH, Alzenau, and K. BEHLER, TÜV-BAYERN, Munich, FEDERAL REPUBLIC OF GERMANY; N. NAGAHAMA and K. ITHO, Kobe Steel Ltd., Takasago, JAPAN

20. Transport/Storage Cask for Long Term Cooled Spent Fuel Elements
W. ANSPACH, NUKEM GmbH, Alzenau; R. CHRIST, NCS GmbH, Frankfurt, FEDERAL REPUBLIC OF GERMANY, and W. BERGMAN, RBU GmbH, Hanau, FRANCE

21. The Behaviour of Neptunium under Reducing Conditions
M. I. PRATOPO, H. MORIYAMA and K. HIGASHI, Kyoto University, Kyoto, JAPAN

22. Study of Cation Adsorption Model on Sodium Bentonite
M. KAWAGUCHI, M. KAMINOYAMA, H. TAKASE and K. SUZUKI, JGC Corporation, JAPAN

23. Radionuclides Sorption Testing of Granite Using Leachate from Fully Radioactive Waste Glass
T. ASHIDA, K. MIYAHARA, M. UCHIDA, Y. YUSA and N. SASAKI, Power Reactor and Nuclear Fuel Development Corporation, Tokai-mura, Ibaraki, JAPAN

24. Radiation Effects on Volumetric Change and Leaching for Simulated Radioactive Waste Glass
S. SATO, Y. INAGAKI and H. FURUYA, Kyushu University, Fukuoka; T. TAMAI, Research Reactor Institute, Kyoto University, Kyoto, JAPAN

25. Effects of Heating and Swelling Processes on the Effective Thermal Conductivity of Buffer Materials
T. KANNO, T. YANO, H. WAKAMATSU and E. MATSUSHIMA, Ishikawajima Harima Heavy Industries (IHI) Co., Ltd., JAPAN

26. Code Development for Analyzing Field Tracer Test Data
T. OHI, K. IDEMISTU, H. UMEKI, Y. YUSA, N. SASAKI, Power Reactor and Nuclear Fuel Development Corporation (PNC), Tokai-mura, Ibaraki, JAPAN, H. NAGURA and A. ISONO, Information and Mathematical Science Laboratory, Inc., Tokyo, JAPAN

27. Long-Term Reaction Path Modeling of Radionuclide Fixation in Geosphere by Spectroscopic Methods
S. NAKASHIMA and T. NAGANO, Japan Atomic Energy Research Institute (JAERI), Tokai-mura, Ibaraki, JAPAN

28. Behaviour of Uranium Migration in Epigenetic Uranium Ore Deposits with Reference to Radioactive Waste Isolation in Geologic Media
K. DOI, Power Reactor and Nuclear Fuel Development Corporation (PNC), Tokai, Ibaraki, JAPAN, and S. HIRONO, Ningyotoge Nuclear Service Co., JAPAN

(continued)

POSTER SESSION 10 (continued)

29. Natural Analogue Study on Engineered Barriers for Underground Disposal of Radioactive Wastes
K. ARAKI, M. MOTEGI, Y. EMOTO and K. KAJI, Chuokaihatsu Corp.; S. IKARI, T. NADA and T. WATANABE, Radioactive Waste Management Co., JAPAN

30. Natural Analogue on Tono Sandstone-Type Uranium Deposit in Japan
T. SEO, Y. OCHIAI, S. TAKEDA and N. NAKATSUKA, Power Reactor and Nuclear Fuel Development Corporation (PNC), Tokai-mura, Ibaraki, JAPAN

31. The Oklo Natural Reactor Gabon: Analog for High-Level Radioactive Waste Disposal
D. G. BROOKINS, University of New Mexico, Albuquerque, NM, U.S.A.

32. Dissolution Mechanisms of Thorium and Uranium Isotopes from Monazite
D. R. OLANDER, Lawrence Berkeley Laboratory, Berkeley, CA, U.S.A., Y. EYAL, Israel Institute of Technology, ISRAEL

33. Speciation and Retardation Phenomena of Neptunium in Underground Environments
S. TANAKA, S. NAGASAKI, H. ITAGAKI and M. YAMAWAKI, University of Tokyo, Nuclear Engineering Research Laboratory, Tokai, JAPAN

34. Development and Applications of Borehole Scanner to Characterize Fractured Rock
T. ISHII, Y. IIZUKA, Y. IZUMIYA and Y. MUKAWA, Shimizu Corp., Tokyo; Y. MATSUMOTO and O. MURAKAMI, CORE Inc., Tokyo, JAPAN

35. Long-Term Strategy for Management of Savannah River Plant Defense High-Level Nuclear Wastes (U)
M. D. BOERSMA, C. B. GOODLET, W. R. McDONNELL and S. D. THOMAS, Westinghouse Savannah River Company, Aiken, SC, U.S.A.

SESSION 11

Tuesday, 2:00 PM–5:20 PM Room B-1

INTERNATIONAL HLW DISPOSAL SYSTEMS

Chairman: M. FREI, U.S. DOE, Washington, DC, U.S.A.

Co-Chairman: W. LUTZE, Hann-Meitner Institut Berlin, GmbH, FEDERAL REPUBLIC OF GERMANY

Co-Chairman: H. FURUYA, Dept. of Nuclear Engineering, Kyushu University, Fukuoka, JAPAN

1. Approaches to Gaining Public Acceptance of Repository Siting: An International Overview
N. J. NUMARK and E. F. WONDER, ERC Environmental and Energy Services Co., Fairfax, VA, U.S.A.

2. High-Level Waste Disposal in Switzerland
C. McCOMBIE, H. ISSLER and I. G. McKINLEY, NAGRA, Baden, SWITZERLAND

3. Evaluation of the Canadian High-Level Waste Research Program in an International Context
L. W. SHEMILT, McMaster University, Hamilton; G. SHENG, Atomic Energy of Canada, Ltd., CANADA

(continued)

SESSION 11 (continued)

4. Disposal Concepts for HLW and TRU Waste in France
J. M. POTIER, ANDRA, Paris, FRANCE

5. Thermal, Operational and Economic Aspects of Repository Design Alternatives
K. D. CLOSS, R. PAPP, W. BECHTOLD, Karlsruhe Nuclear Research Center, Karlsruhe; H. J. ENGELMANN and B. HARTJE, DBE, FEDERAL REPUBLIC OF GERMANY

6. Overview of the U.S. Program for the Disposal of Spent Nuclear Fuel and High-Level Waste
N. J. DAYEM, Jacobs Engineering Group Inc., Washington, DC; M. W. FREI, U.S. Department of Energy, Washington, DC, U.S.A.

SESSION 12

Tuesday, 2:00 PM–5:20 PM Room B-2

DECONTAMINATION AND DECOMMISSIONING

Chairman: S. MENON, Studsvik Nuclear, Nykoping, SWEDEN

Co-Chairman: R. SHINGLETON, Pacific Nuclear Systems, Federal Way, WA, U.S.A.

Co-Chairman: M. ISHIKAWA, Japan Atomic Energy Research Institute, Tokai-mura, JAPAN

1. Evaluation of Contamination on Concrete of JPDR Building
H. YASUNAKA, H. HATAKEYAMA, T. SUKEGAWA, T. KOZAKI and S. YAMASHITA and T. HOSHI, Japan Atomic Energy Research Institute, JAPAN

2. Reactor Coolant System Decontamination at a Large Pressurized Water Reactor Site
A. D. MILLER, Pedro Point Technologies, Pacifica, USA and T. HILLMER, J. N. KESTER, J. R. HENSCH, Arizona Nuclear Power Projects, Phoenix, AZ, U.S.A.

3. Decommissioning Waste Management in Canada
D. S. HOYE and J. L. ARSENEAULT, Atomic Energy of Canada Ltd., Montreal, Quebec, CANADA

4. Decommissioning of Nuclear Fuel Facilities: Technological Experience and R&D
S. IKEDA, M. SHIOTSUKI, H. MIYAO and T. TSUBOYA, Power Reactor and Nuclear Fuel Development Corporation, JAPAN

5. Research Program of Decommissioning Material Reuse in JAERI
M. TANAKA and H. NAKAMURA, Japan Atomic Energy Research Institute, JAPAN

6. Volume Reduction and Material Recirculation by Freon Decontamination
O. BERNERS and D. BUHMANN, Y. YAMASHITA and M. YOSHIAKI, Elektrowatt GmbH, Mannheim, FEDERAL REPUBLIC OF GERMANY

7. Development of Electro-Honing Decontamination Technique
S. SAKAMOTO, H. IIDA and M. WADA, Toshiba Corp., JAPAN

SESSION 13

Tuesday, 2:00 PM-5:20 PM Room C-1

SPENT FUEL STORAGE SYSTEMS AND EXPERIENCE

Chairman: J. M. CREER, Battelle Pacific Northwest Laboratory, Richland, WA, U.S.A.

Co-Chairman: H. S. PARK, Korea Advanced Energy Research Institute, KOREA

1. Comparative Statistics of Spent Fuel Storage Options
A. F. NECHAEV and J. L. ROJAS, International Atomic Energy Agency (IAEA), Vienna, AUSTRIA

2. Overview of Spent Fuel Storage Technologies in Japan-Cask and Vault Types
T. SAEGUSA, C. ITO and M. HIRONAGA, Central Research Institute of Electric Power Industry, Tokyo, JAPAN

3. Design Considerations, Operating and Maintenance Experience with Wet Storage of Ontario Hydro's Used Fuel
C. R. FROST, Ontario Hydro, Toronto, Ontario, CANADA

4. Dry Storage Facility for Spent Fuel or High Level Wastes
J. GEOFFROY and M. DOBREMELLE, CEA Saclay, J. C. FABRE, CEA Marcoule, C. BONNET, SGN, FRANCE

5. Intermediate Storage Systems and Experience with Spent HTR Fuel Elements
R. THEENHAUS and S. STORCH, Jülich Nuclear Research Center (KFA), Jülich, FEDERAL REPUBLIC OF GERMANY

6. Operating Experience With the Spent Fuel Reception and Storage Facilities at the La Hague Reprocessing Plant
R. DABAT, COGEMA, La Hague Center, Cherbourg, J. L. MATHIEN, SGN, La Hague, M. LUNG, SGN, St. Quentin-en-Yvelines, FRANCE

7. Development of a High Burnup Spent Fuel Transport-Storage Cask (MSF-v)
K. OHSONO, K. ANDO, H. KANAZAWA and M. OHASHI, Mitsubishi Heavy Industries, Ltd., JAPAN

SESSION 14

Tuesday, 2:00 PM-5:20 PM Room C-2

VOLUME REDUCTION AND SOLIDIFICATION

Chairman: M. KIKUCHI, Hitachi Works-Hitachi, Ltd., Ibaraki, JAPAN

Co-Chairman: A. MILLER, Pedro Point Technology, Pacifica, CA, U.S.A.

Co-Chairman: T. S. CHOU, Institute of Nuclear Energy Research, Taiwan, CHINA

1. Volume Reduction Technology for Low Level Radioactive Waste
S. YOSHIKAWA and O. AMANO, TEP Co., Tokyo, JAPAN

2. Volume Reduction and Conditioning of ILW and LLW at ENEA Casaccia Center
P. RISOLUTI, ENEA, Roma, ITALY, and S. CAO, G. CALABRESI, D. FILONI, P. MANTOYANI, Rome, ITALY

(continued)

SESSION 14 (continued)

3. Advanced Radioactive Waste Treatment System Using Pelletizing and Cement Glass Solidification Technique
M. KIKUCHI, Hitachi Works, Hitachi Ltd., K. CHINO, Energy Research Lab, Hitachi Ltd.; H. TSUCHIYA, Hitachi Nuclear Engineering Co. Ltd.; Y. KIUCHI, Hitachi Service Eng. Co., Ltd., N. SUMITANI, Kansai Electric Co.; O. AMANO, Tokyo Electric Power Co., Tokyo, JAPAN

4. Immobilization of Technetium in Blast Furnace Slag Grouts
R. D. SPENCE, E. W. McDANIEL and T. M. GILLIAM, Oak Ridge National Laboratory, Oak Ridge, TN; W. D. BOSTICK, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN, U.S.A.

5. Development of Radioactive Wastes Treatment System for Nuclear Power Stations by Toshiba (III)--Volume Reduction and Solidification of Concentrated Wastes and Ion Exchange Resins
H. IRIE, T. TAKAHARA and T. MATSUDA, Toshiba Corp.; H. MATSUURA, K. YASUMURA and Y. NAKAYAMA, NAIG Co., Ltd., JAPAN

6. Cement Wasteform Properties
D. J. LEE and C. G. HOWARD, Atomic Energy Establishment, Dorset; C. R. WILDING, Harwell Laboratory, Atomic Energy Authority, Oxfordshire, UNITED KINGDOM

7. A Review on the Development of Two Immobilization Processes for Low- and Intermediate Level Liquid Wastes in China
Y. FENG-TING, W. SHI-SHENG and J. YUN-QING, Department of Nuclear Fuel, China National Nuclear Corp., Beijing, CHINA

POSTER SESSION 15

Tuesday, 3:00 PM-5:20 PM Rooms G,H

LOW/INTERMEDIATE LEVEL WASTE MANAGEMENT

Chairman: Y. SENDA, NGK Insulators, Ltd., Nagoya, JAPAN

Co-Chairman: P. T. McINERNEY, UK NIREX Ltd., Harwell, UNITED KINGDOM

1. ENEA-NUCLECO Role in the Radwaste Operational Management in Italy
A. COSTA, ENEA, Rome, ITALY; and S. CAO, Rome, ITALY

2. Management of the Radioactive Wastes Arising From the Accident in Goiania, Brazil
A. MEZRAHI and A. M. XAVIER, CNEN, Rio de Janeiro, BRAZIL

3. Development of a Combustible Liquid Filter Cartridge for Nuclear Power Plants
S. MATSUMI, Mitsubishi Heavy Industries, Ltd., JAPAN

4. Development of Radioactive Waste Treatment System for Nuclear Power Stations by Toshiba (ii)—Hollow Fiber Filter for Liquid Wastes Treatment
H. ANDO and F. TAJIMA, Toshiba Corp., K. YAMADA and T. SHIRAI, NAIG Co., Ltd., JAPAN

5. Development of Radioactive Wastes Treatment System for Nuclear Power Station by Toshiba (i)—Application of New Foamless Detergent to Laundry System
T. MATSUDA and S. YAMAGUCHI, Toshiba Corp., T. SHIRAI and Y. NAKAYAMA, NAIG Co., Ltd., JAPAN

(continued)

6. Conditioning of Graphite Bricks from Dismantled Gas Cooled Reactors For Disposal
J. R. COSTES, C. DE TASSIGNY, R. ALAIN and V. HUGUOS, Commissariat a L'Energie Atomique, FRANCE

7. Gas Production from the Biodegradation of Organic Components of Low-Level Radioactive Waste
C. A. MacDONALD, Harwell Laboratory, Atomic Energy Authority, Oxfordshire, UNITED KINGDOM

8. Solidification of LLR.W with Micro Waves
A. BEST and H. GENTHNER, Kraftanlagen AG, Heidelberg, FEDERAL REPUBLIC OF GERMANY

9. Characteristics of Waste Form Improved by Using Admixtures
B. M. RZYSKI and A. A. SUAREZ, Comissao Nacional De Energia Nuclear, Sao Paulo, BRAZIL

10. Safety Evaluation of Materials Containing Sodium Nitrate in Relation to Radioactive Waste Management
H. NAKAHIRA, M. KUBO and H. MAEGUCHI, Sumitomo Metal Mining Co. Ltd.; I. FUKUYAMA, Research Institute of Safety Engineering, JAPAN

11. Immobilization of Tritiated Water in Synthetic Rock
N. NISHIOKA and N. YAMASAKI, Research Laboratory of Hydrothermal Chemistry, Kochi University; H. AMANO, Institute of Plasma Physics, Nagoya University; M. HIGUCHI, Mitsui Construction Corp., JAPAN

12. Total Incineration System for LLRW in the Medical Field
N. NABA, K. NAKAZATO and T. OZUTSUMI, Keio University; Y. OHTAKE, Daikin Industries, Ltd., JAPAN

13. Design and Evaluation of a Pilot Plant for the Solidification of Simulated Spent Ion-Exchange Resins with Unsaturated Polyester
T. S. CHOU, Institute of Nuclear Energy Research; Y. D. LEE, National Tsing Hua University, Taiwan, CHINA

14. Supercompaction, an Accepted Method for Processing Dry Solid Low-and Intermediate-Level Radwaste
R. DELANGE, Fountijne, Vlaardingen, THE NETHERLANDS

15. High Force Compaction Treatment of Noncombustible Waste Materials
K. ASAHINA and T. AKASAKA, Kobe Steel, Ltd., JAPAN

16. System Analysis of Supercompaction Technology in the Volume Reduction of Drums Containing Solid Low-Level Radioactive Waste
A. L. RIVERA, J. M. KENNERLY, R. W. MORROW and L. C. WILLIAMS, Oak Ridge National Laboratory, Oak Ridge, TN, U.S.A.

17. Solidification of ^{137}Cs into Potassium Cobalt Hexacyanoferrate(ii) Ion Exchange
J. LEHTO, R. HARJULA, J. WALLACE and S. HAUKKA, University of Helsinki, Helsinki, FINLAND

18. Immobilization of TRU Wastes in Hydrothermal Synthetic Rock
N. KOZAI, and N. MORIYAMA, Japan Atomic Energy Research Institute; H. IWAMOTO and N. YAMASAKI, Kochi University, JAPAN

19. Study of Krypton Immobilization Technology Using an Ion Implantation and Sputtering Process
W. NAKAJIMA, Y. NAKANISHI and S. I. HAYASHI, Power Reactor and Nuclear Fuel Development Corp.; Y. SANO, I. TAI, T. MIYAZAWA and H. MATSUNAGA, Toshiba Corp., JAPAN

(continued)

20. Source-Term Models Based on Mass-Transfer Analysis and Measurement-Based Source-Term Models for a Geologic Radioactive Waste Repository
C. L. KIM, K. S. CHOI, C. H. CHO, J. W. KIM and I. S. SUH, Korea Advanced Energy Research Institute, Daejeon, KOREA

21. The Automated Inspection and Handling System in Lan-Yu Radwaste Storage Site
C. T. YANG and L. F. LO, Radwaste Administration, Atomic Energy Council, Taiwan, CHINA

22. Immobilization of Radionuclides from a PWR Nuclear Power Plant in Cement Composition
I. PLECAS, J. DRLJACA, A. PERIC, A. KOSTADINOVIC and S. GIODIC, The Boris Kidric Institute of Nuclear Science, Beograd, YUGOSLAVIA; D. TANKOSIC, Bechtel National, Inc., San Francisco, CA, U.S.A.

23. Measurement and Sorting Techniques Qualified for Unrestricted Release of Metals from the Nuclear Industry
J. R. COSTES, D. DA COSTA, G. IMBARD, Commissariat a l'Energie Atomique, Bagnols-sur-Ceze, FRANCE

24. Criteria for a Process Control Program for Cements Solidification Systems in Spanish Nuclear Power Plants
J. L. DE LA HIGUERA and J. L. REVILLA, (CSN) Nuclear Safety Council, Madrid, SPAIN

25. Development of Synthetic Safety Assessment System 'SYSA' for Land Disposal of Low-Level Wastes
M. KAWANISHI, Y. MAKI and Y. MAHARA, Central Research Institute of Electric Power Industry; Y. INOUE and M. HORI, Mitsubishi Research Institute, JAPAN

26. Measuring Low Fissile-Content Concentrations in Radioactive Liquid Wastes and Solid Waste Packages
Y. BEROUD, SGN, Saint Quentin-en-Yvelines, FRANCE

27. Evaluation of the Properties of Cemented Low-Level Wastes Through An Extensive Characterization Program
G. CAROPRESO and G. DeANGELIS, Department of Environmental Protection and Man Health, ENEA, Rome, ITALY

28. REDOX Decontamination Technique Development Using Sulfuric Acid
T. ISHIBE, Chubu Electric Power Co., Ltd.; R. FUJITA, M. EDNA and T. MORISUE, Toshiba Corporation, Tokyo, JAPAN

29. Experience on Melting of Contaminated Steel Scrap and Treatment of Large Quantities of Low-Level Contaminated Steel for Unrestricted Release
U. LOSCHHORN, Kernforschungszentrum Karlsruhe GmbH, Karlsruhe; U. BIRKHOLD, Noell GmbH; W. STASCH, NIS Ingenieurgesellschaft mbH, FEDERAL REPUBLIC OF GERMANY

30. Radioactive Waste Management Programme Associated with the Decommissioning of the Former Eurochemic Reprocessing Plant
J. CLAES and H. MEYERS, Belgoprocess, Dessel, BELGIUM

31. Seismic Considerations in the Design of a Drystore for Intermediate Level Radioactive Waste
J. DUNCAN and C. P. ROGERS, Design Group Partnership, Manchester; M. MYALL, Costain Engineering, Manchester, UNITED KINGDOM

32. Studies of Safety Requirements of Un-uniformly Distributed Low to Intermediate Radioactive Waste Package in Shallow Land Burial
M. HAYASHI and I. ODA, Tokyo Electric Power Environmental Engr. Co., Inc.; K. ISHIZAKI, N. KOYANAGI and H. SAKA-

(continued)

POSTER SESSION 15 (continued)

MOTO, Chichibu Cement Co., Ltd.; H. AMANO, Nagoya University, JAPAN

33. Physical and Chemical Properties of Bentonite Loam Mixture as Backfill Materials
M. KONISHI and Y. OKAJIMA, Okumura Corp.; K. YAMAMOTO and T. YANAGI, Osaka University, JAPAN

34. Research on Safety Evaluation for TRU Waste Disposal
M. SENOO, K. SHIRAHASHI, Y. SAKAMOTO and N. MORIYAMA, Japan Atomic Energy Research Institute; M. KONISHI, Okumura Corporation, JAPAN

35. Field Demonstrative Experiment on Solutes Migration Through Saturated Soil Layer
T. OHNUKI, T. TAKEUCHI, S. KOBAYASHI, T. OZAKI, T. SHIMBO, Y. KAWATA and S. MAEDA, Japan Atomic Energy Research Institute, JAPAN

36. A Comparison of Ozone and Hydrogen Peroxide Processes for Treatment of Mixed and Chelated Wastes
S. E. GENTRY and M. G. NIELSEN, Bechtel National, Inc., Oak Ridge, TN, U.S.A.

SESSION 16

Wednesday, 9:00 AM–12:20 PM Room B-1

SPENT FUEL CONDITIONING AND PACKAGING FOR DISPOSAL

Chairman: B. R. NAIR, Westinghouse Electric Corp., Pittsburgh, PA, U.S.A.

Co-Chairman: J. J. CROSTHWAITE, Fuel Technology Branch, Atomic Energy of Canada, Ltd., Manitoba, CANADA

Co-Chairman: C.-H. TSAI, Radwaste Admin., Atomic Energy Council, Taipei, TAIWAN

1. Management of Spent Nuclear Fuel in Sweden
P.-E. AHLSTRÖM and H. FORSSTRÖM, Swedish Nuclear Fuel and Waste Management Co. (SKB), Stockholm, SWEDEN

2. Nuclear Fuel Waste Container Performance Evaluation and Fabrication Development Studies in the Canadian Program
J. L. CROSTHWAITE, Atomic Energy of Canada Limited, Pinawa, Manitoba; J. A. CHADHA, Ontario Hydro Research Division, Toronto, Ontario, CANADA

3. Technology for Treatment and Conditioning Spent LWR Fuel Cladding Hulls and Hardware
H. MIYAO, S. IKEDA, M. SHIOTSUKI and S. KAWAMURA, Power Reactor and Nuclear Fuel Development Corporation; F. KOMATSU, H. TANABE and T. KANAZAWA, Kobe Steel, Ltd., JAPAN

4. Consolidation Equipment for Spent Nuclear Fuel Channels
M. TAGUCHI, Y. KOMATSU and T. OSE, Kobe Steel, Ltd., JAPAN

(continued)

SESSION 16 (continued)

5. Scenario Study on the Direct Disposal of Spent Nuclear Fuels
J. H. WHANG and H. S. PARK, Korea Advanced Energy Research Institute, Daeduk-Danji, KOREA; R. PAPP, Karlsruhe Nuclear Research Center (KSK), Karlsruhe, FEDERAL REPUBLIC OF GERMANY

6. Final Disposal of Dissolver Sludges, Claddings, Fuel Hardware, and Spent HTGR Fuel Elements in the Federal Republic of Germany
D. NIEPHAUS, E. BARNERT, P. H. BRÜCHER and K. KROTH, Jülich Nuclear Research Center, Jülich, FEDERAL REPUBLIC OF GERMANY

SESSION 17

Wednesday, 9:00 AM–12:20 PM Room B-2

ASSAY, CHARACTERIZATION AND PERFORMANCE MODELING-LLW&ILW

Chairman: T. L. CLEMENTS JR., EG&G Idaho, Inc., Idaho Falls, ID, U.S.A.

Co-Chairman: C. HERFORS, Studsvik Nuclear, Nykoping, SWEDEN

Co-Chairman: L. SHAGGENG, Institute of Atomic Energy, Beijing, CHINA

1. Forecast of Radionuclides Release From Actual Waste Form Geometries
A. A. SUAREZ, B. M. RZYSKI and I. M. SATO, Comissao Nacional De Energia Nuclear-CNEN/SP, Sao Paulo, BRAZIL

2. Use of the Performance Assessment in Yugoslav Radwaste Repository Project
D. TANKOSIC, Bechtel National, Inc., San Francisco, CA, U.S.A.; D. SUBASIC, Republicke Komitet za Energetiku, SR, Hrvatske; Z. LOVASIC, NE Krsko, YUGOSLAVIA

3. Development of Safety Assessment Methodology for Shallow Land Disposal of Low-Level Radioactive Waste
H. MATSUZURU, N. WAKABAYASHI, S. SHIMA, K. KATOH and Y. WADACHI, Japan Atomic Energy Research Institute; A. SUZUKI, University of Tokyo, Tokyo, JAPAN

4. Producing Waste Packages in Western Germany in Accordance With Waste Acceptance Requirements For Final Disposal
W. STEGMAIER and W. PFEIFER, Kernforschungszentrum Karlsruhe GmbH, Karlsruhe, FEDERAL REPUBLIC OF GERMANY

5. A Study on Practical Application of Assay System for Radionuclides in Solid Waste Packages
H. OHNO, The Chubu Electric Power Co., Inc.; M. TSUTSUMI and M. SAWAYANAGI, Radioactive Waste Management Center, Tokyo, JAPAN

6. Safety Optimization in Waste Management Based on Risk Analysis Using Fuzzy Logic
C. PREYSSL, ESA, ESTEC, Noordwijk, THE NETHERLANDS, Y. NISHIWAKI, Vienna, AUSTRIA

7. Derivation of Upper Bound Concentration of LLW for Land Disposal in Taiwan, China
F. D. CHANG, C. T. LIOU, and M. F. SU, Institute of Nuclear Energy Research; S. C. TSAI, CTCI Corporation; Taiwan, CHINA

SESSION 18

Wednesday, 9:00 AM–12:20 PM Room C-1

OPTIMIZATION OF PROCESSING AND HLW OPERATIONS

Chairman: C. G. SOMBRET, CEA, Bagnols-sur-Ceze, FRANCE

Co-Chairman: J. L. McELROY, Battelle Pacific Northwest Lab., Richland, WA, U.S.A.

Co-Chairman: N. TSUNODA, Power Reactor and Nuclear Fuel Development Corp., Tokai-Mura, Ibaraki, JAPAN

? **1. Strategies in the Back End of the Fuel Cycle—An Overview**
J. C. GUAIS and G. CASPAR, COGEMA, Saint Quentin-en-Yvelines, FRANCE

2. Development of a Partitioning Method for the Management of High-Level Liquid Waste
M. KUBOTA, S. DOJIRI, I. YAMAGUCHI, Y. MORITA, I. YAMAGISHI, T. KOBAYASHI and S. TANI, Japan Atomic Energy Research Institute (JAERI), Tokai-mura, Ibaraki-ken, JAPAN

3. Minimisation of Residues from Fuel Dissolution
T. D. HODGSON, United Kingdom Atomic Energy Authority, Harwell Laboratory, Oxfordshire, UNITED KINGDOM

4. Waste Management in the Shutdown of the Decommissioning of the Karlsruhe Reprocessing Plant (WAK)—Preliminary Planning Results
G. ENGELHARDT, G. SCHNEIDER, Karlsruhe Nuclear Research Center (KfK), Karlsruhe, and R. MARX, IFM Linkenheim, FEDERAL REPUBLIC OF GERMANY

5. Operation and Maintenance of the New Waste Calcining Facility
T. H. WAITE, Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, ID, U.S.A.

6. Construction and Commissioning of the PETRA Pilot Plant Facility for Waste Management Studies
H. DWORSCHAK and F. GIRARDI, CEC Joint Research Center, Ispra; G. GROSSI, ENEA Casaccia, ITALY

SESSION 19

Wednesday, 9:00 AM–12:20 PM Room C-2

LOW/INTERMEDIATE LEVEL WASTE DISPOSAL

Chairman: S. SAKATA, Radioactive Waste Management Center, Tokyo, JAPAN

Co-Chairman: R. H. FLOWERS, United Kingdom Atomic Energy Authority, Harwell Laboratory, Oxfordshire, UNITED KINGDOM

Co-Chairman: L. C. OYEN, Sargent & Lundy, Chicago, IL, U.S.A.

1. Disposal of Low-Level Radioactive Solid Waste (LLSW) by Burying in Concrete Vault—Plan of Japan Nuclear Fuel Industry Company, Inc.
H. SHIMODA, Japan Nuclear Fuel Industries Co., Inc., JAPAN

SESSION 19 (continued)

2 **Buried Waste Program at the Idaho National Engineering Laboratory**
C. J. BONZON and S. P. FOGDALL, EG&G Idaho, Inc., Idaho Falls, ID, U.S.A.

√3 **Experiences from the Construction and Operation of the Swedish Final Repository for Radioactive Waste**
H. FORSSTROM, B. GUSTAFSSON and T. HEDMAN, Swedish Nuclear Fuel and Waste Management Co., Stockholm, SWEDEN

4. Initial Operation of Liquid Waste Treatment at the West Vally Demonstration Project
T. W. McINTOSH, W. W. BIXBY and E. MAESTAS, U.S. Department of Energy, West Valley, NY, U.S.A.

5. Archaeological Evidence Supports a Preferred Soil Cap for LLR.W Disposal
K. WATANABE, Saitama University; Research Group ANARG, Archaeological Natural Analog Research Group, JAPAN

6 **Program for Low-Level Radioactive Waste Disposal at the Savannah River Site, A. U. S. Nuclear Material Production Facility**
E. L. WILHITE, J. A. COOK and W. R. McDONELL, E. I. DuPont de Nemours & Company, Aiken, SC, U.S.A.

7 **Performance Experiment of Concrete LLRW Disposal Concrete Vault and Transport Properties**
K. SHIMOOKA, S. TAKEBE, H. LI, F. HIROSUE, K. YAMADA, H. MIYAHARA, Y. WADACHI and K. HIRANO, Japan Atomic Energy Research Institute, JAPAN

SESSION 20

Wednesday, 2:00 PM–4:00 PM Room B-1

HLW DISPOSAL PERFORMANCE ASSESSMENT AND TESTS

Chairman: F. GIRARDI, CEC Joint Research Center, Ispra, ITALY

Co-Chairman: K. HIGASHI, Dept. of Nuclear Engineering, Kyoto University, Kyoto, JAPAN

1 **Preliminary Radionuclide Release Calculations Using the AREST-PNC Code**
A. M. LIEBETRAU, D. W. ENGEL, B. P. McGRAIL and M. J. APTED, Battelle, Pacific Northwest Laboratory, Richland, WA, U.S.A., N. SASAKI and S. MASUDA, Power Reactor and Nuclear Fuel Development Corporation, JAPAN

2 **Reactive Geochemical Transport Problems in Nuclear Waste Analyses**
A. F. B. TOMPSON and R. B. KNAPP, Lawrence Livermore National Laboratory, Livermore, CA, U.S.A.

3 **Risk Assessment for the Final Disposal of Spent Fuel in Taiwan, China**
S. J. LIU and K. L. SOONG, Institute of Nuclear Energy Research, J. J. TAI and L. A. LI, Institute of Statistical Science, Taipei, Taiwan, CHINA

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SESSION 20 (continued)

4. Corrosion Studies on Candidate Overpack Materials
M. NODAKA, H. ISHIKAWA, Y. YUSA and N. SASAKI, Power Reactor and Nuclear Fuel Development Corporation (PNC), Tokai-mura, Ibaraki, JAPAN

5. Technical and Economic Optimization Study for HLW Waste Management
A. DEFFES, CEN-VALRHO, Bagnols-sur-Ceze, Cedex, FRANCE

SESSION 21

Wednesday, 2:00 PM–4:00 PM Room B-1

DRY ACTIVE WASTE (DAW) MANAGEMENT

Chairman: P. WILLIAMS, Paul Williams and Associates, Median, OH, U.S.A.

Co-Chairman: H. R. BURRI, Electrowatt Engineering Services Limited, Zurich, SWITZERLAND

Co-Chairman: C. K. HUANG, Pacific Engineers & Constructors, Taiwan, CHINA

1. Development of Baling Machine for Compressing and Packing Radioactive Solid Wastes
G. ZONGZHOU and J. HUIMIN, Institute of Atomic Energy, Beijing, CHINA

2. Italian Experience on the Processing of Solid Radioactive Wastes
A. COSTA and G. DeANGELIS, Department of Environmental Protection and Man Health, Rome, ITALY

3. Development of High Pressure Compaction System for Non-Combustible Solid Waste
S. YOGO and T. HATA, The Chubu Electric Power Co.; K. TORITA, K. YAMAMOTO and Y. KARITA, NGK Insulators, Ltd., Nagoya, JAPAN

4. State-of-the-Art Dry Active Waste Processing Facility
T. HILLMER, H. INGALSBE and G. ALCORN, Palo Verde Nuclear Generating Station, Wintersburg, AZ; K. ANDERSON and D. DAHLEN, Associated Technical Resources, Inc., Parkridge, IL, U.S.A.

5. Development of Conditioning Technique for Dry Active Wastes Cement
K. YOKOYAMA, T. SASAKI, M. KADO, T. YAGI and Y. MORIYA, JGC Corporation, JAPAN

SESSION 22

Wednesday, 2:00 PM–4:00 PM Room C-1

REGULATORY, PROGRAMMATIC AND INSTITUTIONAL ASPECT OF LLW & ILW MANAGEMENT

Chairman: B. VIGREUX, SGN, Saint-Quentin en Yvelines, FRANCE

Co-Chairman: R. KIYOSE, Tokai University, Kanagawa-ken, JAPAN

Co-Chairman: D. TANKISIC, Bechtel National Inc., San Francisco, CA, U.S.A.

1. Principles and Practice for Disposal of Low and Intermediate-Level Wastes in Sweden
C. BERGMAN, R. BOGE and G. JOHANSSON, National Institute of Radiation Protection, Stockholm, SWEDEN

2. An Information System for the Management of Decommissioning Wastes
G. ENGELHARDT and G. SCHNEIDER, Karlsruhe Nuclear Research Center (KFK); A. RUPALLA, Bigbyte GmbH, Karlsruhe, FEDERAL REPUBLIC OF GERMANY

3. Progress Toward Disposal of LLRW in Canada
D. H. CHARLESWORTH, Atomic Energy of Canada Limited, Chalk River, Ontario, CANADA

4. Radioactive Wastes: Perspectives of Technical Solutions
H. R. FRANZEN, National Nuclear Energy Commission, Rio de Janeiro, BRAZIL

5. Radioactive Waste Management Strategy in Argentina
M. H. DE PAHISSA, J. PAHISSA and T. RAMALLO, Comision Nacional de Energia Atomica, Buenos Aires, ARGENTINA

SESSION 23

Wednesday, 2:00 PM–4:00 PM Room C-2

WASTE MANAGEMENT IN DEVELOPING COUNTRIES

Chairman: M. E. WACKS, University of Arizona, Tucson, AZ, U.S.A.

Co-Chairman: S. RONODIRDJO, BATAN, Jakarta Selatan, INDONESIA

1. System Approach to Waste Management for Developing Nations
T. W. WOODS, Westinghouse Hanford Operations, Richland, WA; M. E. WACKS, University of Arizona, Tucson, AZ, U.S.A.

2. Treatment and Conditioning of Solid Radioactive Wastes Utilizing Modern Technologies
R. KOHOUT and M. GARAMSZEGHY, Ontario Hydro, Toronto, Ontario, CANADA

3. Radwaste Disposal Planning in a Developing Nation With Nuclear Power, Korea
K. W. HAN, KAERI, KOREA; R. KÖSTER, Kernforschungszentrum, Karlsruhe, FEDERAL REPUBLIC OF GERMANY

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SESSION 23 (continued)

4. IAEA Technical Assistance to Developing Countries With Particular Reference to Radioactive Waste Management
J. L. ZHU, D. E. SAIRE and K. THOMAS, IAEA, Vienna, AUSTRIA

5. Waste Management In Developing Countries: A Panel Discussion

Moderator: P. COLOMBO, Brookhaven National Laboratory, Upton, L.I., NY, U.S.A.

Panelists:
H. S. RONODIRDJO, BATAN, INDONESIA
M.E. WACKS, University of Arizona, U.S.A.
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1989 ASME/JSME/AESJ
JOINT INTERNATIONAL
WASTE MANAGEMENT CONFERENCE

OCTOBER 22-28, 1989

LIST OF PARTICIPANTS

ARGENTINE

Pahissa, M.	CNEA Dra in Biochemistry-Head of Department Lvis Saenz Pena 141-40B Buenos Aires

AUSTRALIA

Toussaint, L.B.	Health Department of Western Australia 9 Desford Close, Shelley, West Australia

AUSTRIA

Nechaev, A.	International Atomic Energy Agency Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna
Zhu, J.L.	International Atomic Energy Agency Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna

BELGIUM

Geens Ludo, P.M.	Section Head of Decommissioning, Belgoprocess N.V. Gravenstraat 73, B-2480 Denel
Claes, J.	Gravenstraat 73 Dessel 2480
Roodhooft, R.	Belgian Waste Technology Marsveldstraat, 25, Brussels, B-1050

BRAZIL

Dorea, A.	Division of Thermo Hidraulic, COPESP, Ministerio da Marinha Sao Paulo, Brazil 05508
Franzen, H.R.	Brazilian Nuclear Energy Commission
Kunioshi, R.	IPEN Rijuriti 683 ap 11, Sao Paulo, SP 04520
Silva, C.	Division of Thermo Hidraulic, COPESP, Ministerio da Marinha Sao Paulo, Brazil 05508
Waku, R.J.	Project Manager, COPESP Rua Prof. Lineu Prestes, 2242 Sao Paulo 05598

CANADA

Card, E.	Wardrop Engineering Inc. 600-6725, Airport RD, Mississauga, Ontario L4V 1V2
Chada, J.	Section Head, Ontario Hydro, 800 Kipling Ave., Toronto, Ontario
Charlesworth, D.H.	Atomic Energy of Canada, Ltd. Charles River Nuclear Lab., Charles River, Ontario K0J 1J0
Crosthwaite, J.L.	Whiteshell Nuclear Research Establishment, Atomic Energy of Canada Ltd. Pinawa, Manitoba, R0E 1 L0
Frost, C.R.	Ontario Hydro 700 University Ave., Toronto, Ontario M5G 1X6
Howe, W.F.	Ontario Hydro 700 University Ave., Toronto, Ontario M5G 1X6
Kohout, R.	Ontario Hydro 700 University Ave., Toronto, Ontario M5G 1X6
Shikaze, K.	Environment Canada 25 St. Clair, Ave. E., Toronto, Ontario M4T 1M2
Shemilt, L.W.	McMater Unviersity Hamilton, Ontario L8S 4K1

CHINA

Guan, Z.Z.	Institute of Atomic Enrgy P.O. Box 275, Beijing
Jiang, Y.Q.	China National Nuclear Corp., P.O. Box 2102(10), Beijing 100822
Ju, K.F.	Chinese Nuclear Society P.O. Box 2125, Beijing
Luo, S.G.	Institute of Atomic Energy P.O. Box 275, Beijing
Pan, Z.Q.	China National Nuclear Corp., P.O. Box 2102(14), Beijing
Wang, X.D.	Beijing Insitute of Nuclear Engineering P.O. Box 840, Beijing 100840

Chang, C.M.	Institute of Nuclear Energy Research Lung Tan, P.O Box 3-7, Taiwan
Chiou, M.J.	Nuclear Engineer, Taiwan Power Co. 17TL 242 Roosevelt Road, Section 3, Taipei, Taiwan
Chou, T.S.	INER P.O. Box 3-5, Lung Tan, Taiwan
Fwu, L.L.	Radwaste Administration, A.E.C. 65 Lane, 144 Lanor, Keelung Road 4, Taipei, Taiwan
Huang, C.H.	Institute of Nuclear Energy Research Lung Tan, P.O Box 3-7, Taiwan
Huang, C.K.	Assistant Chief Stant-up Engineer & Project Manager, Pacific Engineers & Constructors, Ltd. 6th Fl, 571, Tun Hua S. Road, Taipei, Taiwan
Jeng, S.M.	CTCI Corp., No. 695, Tun Hua South Road, Taipei 10661, Taiwan
Lee, J.T.	Professor, National Cheng Kung University 1, Ta Hsueh Road, Tainan, Taiwan
Rougeau, F.	Societe Generale Pour les Techniques Nouvelles 11, Lane 78 Chienkuo North Rd., Section 1, Taipei, Taiwan
Shar, S.C.	Radwaste Division Head, Taiwan Power Co. P.O. Box Shih-Men, Taipei Hsie, Taiwan
Shiao, S.J.	National Chiao Tung University, 1001 Ta Hsueh Road, Hsinchu 30050, Taiwan
Shih, C.L.	Associate Scientist, Institute of Nuclear Energy Research P.O. Box 3-3, Lung-Tan, 32500, Taiwan
Tsai, C.M.	Director, RNA/aec 65, 144 Lave Sect. 4, Keelong Road, Taipei, Taiwan
Tsai, S.C.	CTCI Corp., No. 695, Tun Hua South Road, Taipei 10661, Taiwan
Tseng, D.T.Y.	Senior Vice President & Marketing Director, China Advanced Technologies Corp. P.O. Box 3G-1043, Taipei, Taiwan
Yang, C.T.	Superintendent, Radwaste Administration, Atomic Energy Council Taipei, Taiwan

FINLAND

Lefto, J.	Department of Radiochemistry, University of Helsinki Unioninkatu 3S, 00170 Helsinki
Muurinen, A.	Technical Research Centre of Finland Otakaar 3A AF-02150 Espoo
Tusa, E.	Imatran Voima Oy, P.O. Box 112, SF-01601, Vantaa

FRANCE

Beroud, Y.	SGN 1 rue des Herons, St. Quentin, Yvelines 78182
Blum, P.	Delegated Director, Transnucleaire 11 R. Christophe Colomb, Paris
Bonnet, C.	SGN 1 rue des Herons, St. Quentin, Yvelines 78182
Capitini, R.	French Atomic Energy Commission, DESICP/DLPC/91191 Gif-Sur, Yvette
Carpentier, S.	SGN 1 rue des Herons, St. Quentin, Yvelines 78182
Courtois, C.	CEA Cen Cadarache 13108, St. Paul Lez Durance
Dobremelle, M.	CEA DEMT/SYST/TCY, GIF SUR YVETTE, 91191 Cedex
Geffroy, J.	CEA DEMT/SYST/TCY, GIF SUR YVETTE, 91191 Cedex
Guais, J.-C.	COGEMA, 2, Rue PAUL Dautier - BP 4 Velizy - Villacoublay, Cedex 78141
Lefevre, J.	CEA DEMT/SYST/TCY, GIF SUR YVETTE, 91191 Cedex
Lung, M.	SGN 1 rue des Herons, St. Quentin, Yvelines 78182

Potier, J.M.	Project Manager, ANDRA 31-33 rue de la Federation, Paris
Sombret, C.	Commissariat a l'Energie Atomique BP. 171, Bagnols, Ceze 30205
Vigreux, B.	SGN 1 rue des Herons, St. Quentin, Yvelines 78182

F. R. GERMANY

Anspach, W.	NUKEM GmbH Industriestrasse 13, Alzenau Bayern 8755
Baumgartner, F.	Institute of Radiochemistry, Technical University, Munchen, Garching, Bavaria 8046
Best, A.	Kraftanlagen AG., IM Breitspiel 7, Heidelberg, BRD
Bohm, H.	Nuclear Research Center, Karlstruhe, Postfach 3640, Karlstruhe 3640
Buhmann, D.	Elektrowatt Ing. GmbH Al s-Senefelder Str. 1-3, Mannheim
Closs, K.D.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Emrich, F.	NUKEM GmbH Industriestrasse 13, Alzenau Bayern 8755
Furrer, J.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Geel, J.V.	Director Euratom, European Community Oetelsbachstrasse 20, Ettlingen
Grabenstatter, K.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Holl, F.	Kraftanlagen AG., IM Breitspiel 7, Heidelberg, BRD
Kelm, M.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500

Kinner, J.	Kraftanlagen AG., IM Breitspiel 7, Heidelberg, BRD
Koester, R.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Kraemer	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Kunz, W.	DWK Hamburger Allee 4, Hannover 3000
Loschhorn, U.	Kernforschungszentrum Postfach 3640, Karlstruhe D-7500
Morz, E.R.	Director, Institute of Chemical Technology, Nuclear Research Center (UFA) Juelich P.O. Box 1913, Juelich D-5170
Niephans	Kernforschungsanlage Fulich GmbH Postfach 1913, D-5170 Fulich
Rupalla, A.	Bigbyte, Luideuallee 4F, Varlstruhe 7500
Schneider, G.E.	Kernforschungszentrum Weberstr. 5, P.O. Box 3640, Karlstruhe 7500
Schultes, E.	NUKEM GmbH Industriestrasse 13, Alzenau, Bayern 8755
Stegmaier, W.	Kernforschungszentrum Weberstr. 5, P.O. Box 3640, Karlstruhe 7500
Storch, S.	Kernforschungsanlage Fulich GmbH Postfach 1913, D-5170 Fulich

HUNGARY

Kovacs, J.V.	Technical University Budabest -1124 Budabest, Lolyom L. 9

ISRAEL

Eyal, Y.	Professor, Technion-Israel Institute of Technology Haifa, Israel 32000

ITALY

Clemente, D.	Nuclear Operations Manager, ENEL Via Torino 6, Rome
De Angelis, G.	ENEA Via Anguillarese 301, Rome 0060
De Crescenzo, V.	Assistant to the Director, ENEA Via Vitaliano Brancati 48, Rome 00144
Dworschak, H.	Division Head, Nuclear Fuel Cycle Department, Commmission of European Communities, Joint Research Center, Ispra, Varese
Eletti, G.	ENEA/DISP Via V. Brancati n.48, Rome 00144
Giancarlo, S.	Research Manager, ENEL-Thermal and Nuclear Research Center Via Rubattino 5, Milano 1-20134
Girardi, F.	Adviser, Institute for the Environment, Commission of European Communities Joint Research Centre, Ispra (Varese) 21020
Pasquale, R.	Ministero Cavoro E. Prev. Soc. Via Flavia 3, Rome
Tommaso, V.	ENEL Production Energy Napoli

KOREA

Han, K.W.	Head, Korea Advanced Energy Research Institute P.O. Box 7, Daeduk Danji, Daejoen
Ko, K.S.	Manager, Radwaste Management, Nuclear Energy Department KOPEC 87 Samsong-dong, Kangnam-ku, Seoul
Kim, C.L.	Senior Researcher, Korea Advanced Energy Research Institute P.O. Box 7, Daeduk Danji, Daejoen
Lee, B.S.	Korea Power Engineering Co., Inc. P.O. Box 807 Youngdong, Seoul
Park, S.H.	Manager, Nuclear Safety Center, Korea Advanced Energy Research Institute 10-103 Kong Dong Kwar Ri art. Do Kyondong You Sung, Dae Jeon
Whang, J.	Senior Researcher, Korea Advanced Energy Research Institute P.O. Box 7 Daeduk Danji, Daejoen

THE NETHERLANDS

Codée, H.D.K.	Central Organization for Radioactive Waste (COVRA) N.V. P.O.Box 20, Petten, 1755 ZG
De Lange, R.C.	Sales Office Manager, Fontyne Holland B.V. Dennendal 133, Maassluis 31LIR LC
Preyssi, C.	Physicist, European Space Agency P.O. Box 294, 2200 AG Noordwivk
Vrijen, J.	Central Organization for Radioactive Waste (COVRA) N.V. P.O.Box 20, Petten, 1755 ZG

PAKISTAN

Ahmad, S.M.	Institute of Industrial Automation 131, Sf. 65 F-10-3, Islamabad
Chowhan, R.A.	Med. Dir., Institute of Industrial Automation B18, St. 17, E7, Islamabad
Rehman, R.U.	Institute of Industrial Automation 131, Sf. 65 F-10-3, Islamabad

SWEDEN

Ahlstrom, P. E.	Swedish Nuclear Fuel and Waste Management Co. Box 5864, S-102 48, Stockholm
Bergman, C.	National Institute of Radiation Protection P.O.Box 60204, Stockholm S-104 01
Bjerler, J.	Stensand AB Box 46 Vaeroebacka 43022
Forsström, H.G.	Swedish Nuclear Fuel and Waste Management Co. Box 5864, S-102 48, Stockholm
Gustafsson, B.	SKB Box 5864, Stockholm S-10248
Harfors, C.	Vice President, Studsvik AB S-61182 Nykoping
Ingemar, P.	Swedish State Power Board Ringhals Nuclear Power Plant, Vaeroebacka 43022
Johansson, B.	Stensand AB Box 46 Vaeroebacka 43022
Korotenski, M.	Swedish State Power Board S-74200 Oesthammar
Lowendahl, B.	OKG Aktiebolag/Oskarshanin NPP S-57093 Figeholm
Lundgren, P.	Karnkraftteknik AB Box 37, 18271 Stocksund
Monsen, A.	Swedish State Power Board S-74200 Oesthammar
Petterson, S.	Design and Construction, Swedish State Power Board S-16287 Vallingby
Shankar, M.	Studsvik AB S-61182 Nykoping
Sjöblom, R.	National Broad Forspcur Nud Sehlstedtsgafen 9 Stockholm
Stenberg, T.A.	Swedish State Power Board Tantlandsgt 99, S-16287, Vallingby
Stroemberg, E.	Stensand AB Box 46 Vaeroebacka 43022
Sundström, U.	Material Development, Fuel Division ABB Atom AB S-721 63 Vasteras

SWITZERLAND

Issler, H.	Nagra, Parkstrasse 23, Baden, AG, CH-5401
Selinger, J.	General Manager, Waste Managereni E. Wirz A9 8105 Regensdorf Switzerland Althardsernssf, 224, Regensdolf, Zurich
Theenhaus, R.	Kernforschungsanlage Zurich GmbH P.O.B. 1913, 5170 Zurich
Thury, M.	Nagra, Parkstrasse 23, Baden, AG, CH-5401

THAILANDS

Sriyotha, P.	Chemist, OAEP Vibravadu Rangsit Road, Bankok

U. K.

Blakeway, S.J.	Power Project Group, National Power
Boorman, T.	United Kingdom Atomic Energy Authority, Northern Research Laboratories, Windscale Seascale Cumbria C20 1JF
Bowers, W.	B.N.F.L. Risley Warrington Cheshire WA3 6AS
Capp, P.	AEA Technology, AEA Technology Centre Winfrith Dorchester DT2 8DH
Carter, P.B.	Commercial and Technical Applications Manager, Overseas Oxide Reprocessing Division, British Nuclear Fuels PLC Fleming House, Risley, Warrington, WA3 6AS
Colquhoun, A.	British Nuclear Fuels Plc Seliafield, Ciembris
Connop, R.	British Nuclear Fuels Risley, Warrington, Cheshire WA3 6AS
Cross, J.E.	UKAEA, Harwell Laboratory, Chemistry Division, Bio. 5 Didect, Oxfordshire, OX11 ORA
Feates, F.S.	Department of Environment RM A538 Romney House, 40 Marsham St, London SW1P 3P4
Fellingham, L.	AEA Technology, Harwell Laboratory Oldcot Oxfordshire OX11 ORA

Flowers, R.H.	Harwell Laboratory, United Kingdom Atomic Energy Authority, Oxfordshire Ox 11 ORA
Gregory, C.V.G.	AEA Technology, Dounreay Caithness, Scotland KW14 7TZ
Hardacre, A.G.	UKAEA, Harwell Laboratory Didcot Oxon, OX11ORA
Haslam, S.	BNFL Risley Warrington Cheshire WA3 6AS
Heafield, W.	BNFL Warrington, Cheshire
Hodgson, T.	AEA Technology, Harwell Laboratory Oldcot Oxfordshire OX11 ORA
Hooper, E.W.	Harwell Laboratory, AEA Technology, Oxfordshire Ox 11 ORA
Jenkins, T.	AEA Technology, Harwell Laboratory Oldcot Oxfordshire OX11 ORA
McInerney, P.T.	U.K. Nirex, Ltd. Cupie Ave., Harwell, Didcot, Oxon OX11 ORH
Panton, L.	Nuclear Transport, Ltd. Risley Warrington Cheshire WA3 6AS
Passant, F.	CEGB/National Power Barnett Way Barnwood Gloucester Glos GL4 7RS
Peats, F.S.	Department of the Environment RM A 538
Pool, D.E.	Nuclear Installations Inspectorate St. Peters House, Balliol Road, Bootle, Merseyside L70 9JR
Shaw, H.	British Nuclear Fuels PLC Risley Warrington Cheshire
Simmonite, A.	AEA Technology, Dounreay Caithness, Scotland KW14 7TZ

Smith, I.J.	British Nuclear Fuels Risley Warrington Cheshire
Taylor, J.	Uranium Institute Bowater House 68, Knightsbridge, London SW1K 7LT
Watson, D.	British Government 30 Woodpecker Center, Winfrith Dorchester DT2 8DH

U. S. A.

Allen, C.R.	Battele Pacific Northwest Laboratory P.O. Box 999, Richland, WA 99352
Baker, R.C.	Senior Program Manager, Depository Technology Program U.S. Department of Energy, U.S. Chicago Operations Offi c, Argonne, IL 60439
Bakevich, G.J.	Interstate Nuclear Services 295 Parker St., P.O.Box 51457, Springfield, MA 01151
Bale, M.G.	Manager, A.A.R. Brook & Perkins 12633 Inkster Rd. Livonia, M.I.
Bayer, R.	Project Manager, Dominion Energy P.O. Box 26532, Richmond, V.A.
Benzon, C.J.	Idaho National Engineer Laboratory P.O.Box 1625, Idaho Falls, ID 83415
Chapman, C.	Group Leader, Battelle-Pacific Northwest Laboratories Box 999, P741, Richland, WA 99352
Clements, T.L.	EG&G Idaho, Inc. P.O. Box 1625, M.S. 4201, Idaho Falls, Idaho 83415
Colombo, P.	Group Leader, Brookhauen National Lab., Bldg. 703, Upton, N.Y.
Comprelli, F.A.	Bechtel National, Inc. P.O. Box 3965, San Francisco, CA 94119-3965
Dahlen, D.	Vice President, Associated Technical Resource, Inc. 1550 N. Northwest Highway, Suite 200, Park Ridge, I.L.
Dayem, N.J.	Jacobs Engineering Group 1234 National Press Bldg., 529 14th St. NW, Washington D.C. 20045
Djurica, T.	Task Manager, Bechtel National Inc. 8225 Geary, San Francisco, CA

Duffy, L.P.	U.S. Department of Energy 1000 Independence Ave., S.W., Washington D.C. 20585
Falci, F.P.	Manager, Nuclear Materials Transport, U.S. Department of Energy 8905 Copenhaver Drive, Potmac, M.D.
Falconer, K.L.	Manager, Technical Services, UNC 743 Horizon Court, Suite 200, Grand Junction, C.O.
Feizollahi, F.	Bechtel National, Inc. 50 Beale St. San Francisco, CA 94105
Frei, M.W.	U.S. Department of Energy 1000 Independence Ave., S.W., Washington D.C. 20585
Galpin, F.L.	U.S. Environmental Protection Agency 401 M St. SW Washington D.C. 20460
Glusic, J.J.	President, Associated Technical Resources Inc. A.T.R., Inc. 1550 N. Nothwest Highway, Suite 200, Park Ridge, I.L.
Hammen, R.	President, Chromato Chemical, Inc. 4200 Fox Farm Rd., Missoula, M.T.
Harlan, R.A.	Rockwell International P.O. Box 464, Golden, C.O.
Harmon, L.H.	Director, Transportation Management, U.S. Department of Energy DP-121, Washington, D.C.
Heinrich, L.R.	Westinghouse Savannah River Site, Aiken, S.C. 29808
Hillmer, T.P.	Manager, Radwaste Support, Arizona Public Service 10212 N. 53 Lane, Glendale, A.Z.
Isayama, T.	JGC Corp. 701 E. Byrd Street 17th Floor, Richmond, Virgnia 23219
Johnstone, G.A.	Interstate Nuclear Services 295 Parker St., P.O.Box 51457, Springfield, MA 01151
Justus, P.	Division of High-Level Waste, 4-4-3 U.S. Nuclear Regulatory Commission Washington D.C. 2055

Kitchen, B.G.	Westinghouse Savannah River Co. Savannah River Lab., P.O. Box 616, Aiken, S.C. 29802
Kruse, P.W.	U.S. Marketing Representative, JGC Corp. 20 Avon Merdaw Lane, Suite 220, Avon, C.T.
Kuhn, W.L.	Battele Pacific Northwest Laboratory P.O. Box 999, Richland, WA 99352
Leigh, I.W.	Pacific Northwest Laboratory P.O. Box 999, Mailstop K6-24, Richland, WA 99352
Lester, W.	Vice Chairman, Duratek Corp. 6700 Akexanderbell Drive, Columbia, M.D.
Liebetrau, A.M.	Battele Northwest Laboratory P.O. Box 999, Mailstop K2-32, Richland, WA 99352
McDaniel, E.W.	Oak Ridge National Laboratory P.O. Box 2003, Oak Ridge, TN 37831-7274
McDonell, W.R.	Westinghouse Savannah River Co. Savannah River Lab., P.O. Box 616, Aiken, S.C. 29802
McElroy, J.L.	Battele Northwest Laboratory P.O. Box 999, Richland, WA 99352
Merenda, F.L.	The PQ Corp. P.O. Box 840, Valley Forge, PA 19482
Michener, T.E.	Pacific Northwest Laboratory, Battelle P.O. Box 999, Richland, W.A.
Murphie, W.E.	U.S. Department of Energy 609 Smallwood Road, Rockville, MD 20850
Nair, B.R.	Westinghouse Electric Corp. P.O. Box 3912, Pittsburgh, PA 15230
Ohkawa, S.	Westinghouse Electric Corp., P.O.Box 3912, Pittsburgh, PA 15230
Oyen, L.C.	Sargent & Lundy 55 East Monroe Street, Chicago, IL 60603

Ozaki, C.B.	EG&G Idaho, Inc. P.O. Box 1625, Idaho Falls, ID 83415-2411
Philippone, R.L.	Bechtel National Inc. 323 Lousiana Ave., Oakridge, T.N.
Pierce, G.D.	Technical Director, S.M. Stoller Corp. 4665 Indian School, N.E. #104, Albuquerque, N.M.
Saxman, P.A.	U.S. Department of Energy, P.O.Box 5400, Albuquerouf, NM 78115
Schneider, K.J.	Pacific Northwest Laboratory P.O. Box 999, Mailstop K6-24, Richland, WA 99352
Schmitt, R.C.	Manager-Program, EG&G Idaho Box 1625, Idaho Falls, ID
Shingleton, R.L.	Pacific Nuclear Systems, Inc. 1010 S. 336th Street, Federal Way, WA 98003
Simmons, G.L.	SAIC 10210 Campus Point Drive, San Diego, CA 92121
Slate, C.C.	Battele Pacific Northwest Laboratory P.O. Box 999, Richland, WA 99352
Smith, R.A.	Vice President, ICF Kaiser Engineers, Inc., 9300 Lee Highway, Fairfax, V.A.
Straker, E.	Sector V.P., SAIC 10260 Campus Point Drive, San Diego, CA 92025
Taylor, G.M.	Nuclear News/ANS 555 N. Kensington Ave., La Grange Park, IL 60525
Tillman, J.B.	Project Manager/WIPP, U.S. Department of Energy 815 Firestone, Carlsbad, c.f.
Tompson, A.F.B.	Lawrence Livermore National Laboratory P.O. Box 808, Livermore, CA 94551

Waeks, M.E.	Department of Nuclear & Energy Engineering, University of Arizona Tucson, Arizona 85721
Waite, T.T.	WINCO Box 4000 Idaho Falls, ID 83402
Wilhite, E.L.	Westinghouse Savannah River Co. Savannah River Lab., P.O. Box 616, Aiken, S.C. 29802
Williams, P.C.	President, Paul Williams & Associates 3364 E. Smith Rd., Medina, Ohio
Wilson, G.R.	INS Corp. P.O. Box 51957, Springfield, MA 01151
Wolfe, B.A.	Westinghouse Hanford Co. P.O. Box 1970 B2-04, Richland, WA 99352

U. S. S. R.

Nikiforov, A.S.	Union Scientific and Research Institute of Numorganic Motor, Moscow
Nikipelov, B.V.	Ministry of Atomic Energy and Power Industry Moscow
Nikitin, M.K.	USSR State Community for Utilization of Atomic Energy 109180, Staromonetry Str., 26, Moscow

YUGOSLAVIA

Subasic, D.	Republic Committee for Energy Iblerov Trg. 9, 41000 Zagreb

JAPAN

Abe, M.	Research Engineer, Department of Environmental Safety Research, Japan Atomic Energy Research Institute Tokai-mura, Naka-gun, Ibaraki
Abe, M.	Professor, Department of Chemical, Tokyo Institute of Technology 2-12-1, Ookayama, MeguroOku, Tokyo
Aisaka, M.	Manager, Nuclear Power Section, Nuclear Power Department, Hokkaido Electric Power Co., Inc. Higashi 1-2, Ohdori, Chuo-ku, Sapporo-shi, Hokkaido
Aizawa, K.	President, Rad Systems Co., Ltd. 7-8-1, Minami Aoyama, Minato-ku, Tokyo
Aizawa, M.	CE 1 Department, Nuclear Power Plant System Engineering Section, Hitachi Engineering Co., Ltd. 3-2-1, Saiwai-cho, Hitachi-shi, Ibaraki 317
Akasaka, T.	Nuclear Engineering and Equipment Department, Kobe Steel Ltd. Tekko Bldg., 1-8-2, Marunouchi, Chiyoda-ku, Tokyo
Akimoto, I.	Senior Managing Director, Mitsubishi Metal Corp., 1-6-1, Ote-machi, Chiyoda-ku, Tokyo
Amano, H.	Technical Consultant, Chichibu Cement Co., Ltd. 2-1-1, Tsukimi-cho, Kumagaya-shi, Saitama
Amanuma, T.	Technical Consultant, Nuclear Safety Research Association, 1-2-2, Uchisaiwai-cho, Chiyoda-ku, Tokyo
Ann, J.H.	Dept. of Nuclear Engineering, University of Tokyo, Fellow of the Japan Society for the Promotion of Science, 7-3-1, Hongo, Bunkyo-ku, Tkyo 113
Aono, T.	Engineeer, Coordination Section, Waste Plants Operation Division, Power Reactor & Nuclear Development Corporation, Muramatsu, Tokai-mura, Naka-gun, Ibaraki
Araki, K.	General Manager, Department of Environmental Engineering, Chuo Kaihatsu Corp. International 3-12-3, Nishi-Waseda, Shinjuku-ku, Tokyo 169
Aritomi, M.	Associate Professor, Research Laboratory ofor Nuclear Reactors, Tokyo Institute of Technology, 2-12-1, Okayama, Meguro-ku, Tokyo 152
Asahina, K.	Assistant General Manager, Nuclear Engineering and Equipment Department, Kobe Steel Ltd. Tekko Bldg., 1-8-2, Marunouchi, Chiyoda-ku, Tokyo
Asakura, Y.	Waste Plants Operation Division, Power Reactor & Nuclear Development Corporation, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Asano, N. Nuclear Business Development Division, Technical Department, Sumitomo Heavy Industries, Ltd.
1, Kanda Mitoshiro-cho, Chiyoda-ku, Tokyo 101

Asano, R. Manager, Design Department, Nuclear Division, Hitachi Zosen Corp.,
1-3-40, Sakurajima, Konohana-ku, Osaka-shi, Osaka 554

Asano, Y. Department of Fuel and Material Research, Japan Atomic Energy Research Institute,
2-4, Shirakata-Shirane, Tokai-mura, Ibaraki

Ashida, T. Waste Technology Development Division, Power Reactor & Nuclear Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Ban, A. Nuclear Electrical Section, Toshiba Engineering & Construction Co., Ltd.
3-3-21, Isogo, Isogo-ku, Yokohama-shi, Kanagawa

Banno, K. Research Engineer, Kajima Institute of Construction Tehnology, Kajima Corp.,
2-19-1, Tobitakyu, Chofu-shi, Tokyo

Bassetiere, H. President, SGN Co., Ltd.,
c/o Uraban Toranomon Bldg., 1-16-4, Toranomon, Minato-ku, Tokyo

Bensnard, P. Assistant Manager, SGN Co., Ltd.,
c/o Uraban Toranomon Bldg., 1-16-4, Toranomon, Minato-ku, Tokyo

Cheng, W.-K. Graduate Student, Department of Nuclear Engineering, Kyushu University
6-10-1, Hakozaki, Higashi-ku, Fukuoka-shi, Fukuoka 812

Chino, K. Senior Researcher, Energy Research Laboratory, Hitachi, Ltd.,
1168, Moriyama-cho, Hitachi-shi, Ibaraki

Doi, K. Radioactive Waste Management Project, Power Reactor & Nuclear Development Corporation,
1-9-13, Akasaka, Minato-ku, Tokyo

Eda, H. Assistant General Manager, Tokai NPS, Japan Atomic Power Co.
1, Shirakata, Tokai-mura, Naka-gun, Ibaraki

Elmendorf, J. President, Westinghouse Energy Systems Japan Co.
1-7-1, Yuraku-cho, Chiyoda-ku, Tokyo

Fujiki, K. Nuclear Power Department, Hokuriku Electric Power Co., Inc.
15-1, Ushijima-cho, Toyama-shi, Toyama

Fujishita, Y. Senior Officer, Nuclear Power Department, Tohoku Electric Power Co., Inc.
3-7-1, Ichiban-cho, Aoba-ku, Sendai-shi, Miyagi

Fujita, R.	Deputy Manager, Nuclear Engineering Laboratory, Toshiba Corp. 4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210
Fukao, A.	Deputy Manager, Nuclear Department, Sumitomo Chemical Co. 9-1, Kitasode, Sodegaura-machi, Kimitsu-gun, Chiba
Fukuda, S.	Associate General Director, Central Research Institute of Electric Power Industires 1-6-1, Ote-machi, Chiyoda-ku, Tokyo
Fukuda, T.	Tokyo Electric Power Company 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo
Fukudome, K.	Researcher, Project Development Section, R&D Center, Kobe Steel Ltd. 1-3-18, Wakinohama-cho, Chuo-ku, Kobe-shi, Hyogo
Furukawa, O.	Manager, Technical Section, Japan Radioisotope Association Takizawa Laboratory Tomegamori, 23 Takizawa-mura, Iwate-gun, Iwate 020-01
Furuya, H.	Professor, Department of Nuclear Engineering, Kyushu University, 6-10-1, Hakozaki, Higashi-ku, Fukuoka-shi, Fukuoka 812
Futami, T.	Assistant Manager, Project Engrg. Dept., Nuclear Energy Division, Sumitomo Metal Mining Co., Ltd., 5-11-3, Shinbashi, Minato-ku, Tokyo
Goto, K.	Radioactive Waste Management Project, Power Reactor & Nuclear Fuel Development Corporation, 1-9-13, Akasaka, Minato-ku, Tokyo
Goto, T.	Research Scientist, Reactor Chemistry Department, Nuclear Research lab., Nippon Atomic Industry Group Co., ltd., 4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa
Haga, C.	Senior Staff, Department of Development Policy Promotion 1-1-13, Shinbashi, Minato-ku, Tokyo 105
Hagiwara, O.	Radiation Safety Control Div., Nuclear Power Plant Operation & Maintenance Dept., Tokyo Electric Power Co., 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo
Hara, K.	Assistant Senior Engineer, Geological Isolation Section, Power Reactor & Nuclear Fuel Development Corporation, 4-33, Muramatsu, Tokai-mura, Naka-gun, Ibaraki
Harada, Y.	Manager, NKK Corp., 2-1, Suehiro-cho, Tsurumi-ku, Yokohama-shi, Kanagawa
Hasegawa, T.	Deputy General Manager, Engineering Department, Nuclear Power Division, Shimizu Corp. Mita 43 Mori Bldg., 13F, 3-13-16, Mita, Minato-ku, Tokyo

Hashiba, K. Manager, Nuclear Plant Equipment Designing Section,
Mitsubishi Heavy Industries, Ltd.,
1-1-1, Wadasaki-cho, Hyogo-ku, Kobe-shi, Hyogo 652

Hashimoto, H. Manager, Radiation Control and Safety Section,
Chubu Electric Power Co., Inc.
1, Toshin-cho, Higashi-ku, Nagoya-shi, Aichi

Hashimoto, N. Nuclear Engineer, JGC Corp.,
1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa 232

Hashimoto, Y. Design Department, Nuclear Division, Hitachi Zosen Co., Ltd.,
1-3-40, Sakurajima, Konohana-ku, Osaka-shi, Osaka

Hashimoto, Y. Executive Director,
Power Reactor & Nuclear Development Corporation,
1-9-13, Akasaka, Minato-ku, Tokyo

Hatta, M. Section Manager, Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industries Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokahama-shi, Kanagawa

Hayase, Y. Nuclear Power Development Projects Administration Department,
Tokyo Electric Power Co.
1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Hayashi, A. General Manager, Hazama-gumi Ltd.
2-5-8, Kita-Aoyama, Minato-ku, Tokyo 107

Hayashi, S. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Higashi, K. Professor, Department of Nuclear Engineering, Kyoto University
Yoshida-Honcho, Sakyo-ku, Kyoto-shi, Kyoto 606

Hirabayashi, K. Manager, NKK Corp.,
1-1, Minamiwatarida, Kawasaki-ku, Kawasaki-shi, Kanagawa

Hirano, K. Director, Deaprtment of Environmental Safety Research,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Hirayama, F. Research Scientist, Nuclear Research lab.,
Nippon Atomic Industry Group Co., ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Hirose, K. Diector, Nuclear Back -End Protection Office, Atomic Energy Bureau,
Scientific and Technology Agency, Japan
2-2-1, Kasumigaseki, Chiyoda-ku, Tokyo 100

Hirose, Y. Manager of Reprocessing Plant, Hitachi Work, Hitachi, Ltd.,
3-1-1, Saiwai-cho, Hitachi-shi, Ibaraki 317

Hirota, K. Lead Engineer, R&D Department, Nuclear & Electric Power Group,
Toyo Engineering Corp.,
Kasumigaseki Bldg. 5F, 3-2-5, Kasumigaseki, Chiyoda-ku, Tokyo

Honda, Y. Senior Deputy Manager, No.1 Sales Department, Nuclear Division, JGC Corp., 2-2-1, Ote-machi, Chiyoda-ku, Tokyo 100

Horie, M. Senior Staff, Power Reactor & Nuclear Fuel Development Corp., 4-33, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Horita, M. Assistant Manager, Radioactive Waste Group, Shimizu Corp. Mita 43 Mori Bldg., 13F, 3-13-16, Mita, Minato-ku, Tokyo Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Hosen, M. Manager, Reactor Safety & Radiological Protection, Kyushu Electric Power Co., Inc. 2-1-82, Watanabe-dori, Chuo-ku, Fukuoka-shi, Fukuoka

Hoshi, T. Reactor Decommissioning Operation Division, Department of JPDR, Japan Atomic Energy Research Institute Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Hoshikawa, K. Manager, Nuclear Safety Division, Nuclear Department, Shikoku Electric Power Co., Inc. 2-5, Marunouchi, Takamatsu-shi, Kagawa

Hoshino, M. Director, Nuclear Power Department, Tokyo Electric Power Environmental Engineering Co., Inc., 3-14-12, Shibaura, Minato-ku, Tokyo

Hozumi, M. Nuclear Business Development Division, Technical Department, Sumitomo Heavy Industries, Ltd. 1, Kanda Mitoshiro-cho, Chiyoda-ku, Tokyo 101

Ibaraki, Y. Head, Atomic Power Department, Atomic Power Headquarters, Kimura Chemical Plant Co., Ltd. 2-1-2, Terajima, Kuise, Amagasaki-shi, Hyogo

Ichihashi, T. Senior Research Scientist, Reactor Chemistry Department, Nippon Atomic Industry Group Co., ltd., 4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Idemura, H. Managing Director, Chiyoda Corp., 2-12-1, Tsurumi-Chuo, Tsurumi-ku, Yokohama-shi, Kanagawa 230

Igarashi, H. Manager, Power Reactor & Nuclear Fuel Development Corp., 4-33, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Iida, T. Nuclear Group, Machinery Division, Kobe Steel, Ltd. 2-3-1, Araicho-Shinhama, Takasago-shi, Hyogo

Iimura, H. Deputy Manager, Tokyo Electric Power Co. 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Iji, H. Shimizu Corp. 3-4-17, Koshinakajima, Koto-ku, Tokyo

Iji, T. Managing Director, Kyushu Electric Power Co., Inc.
2-1-82, Watanabe-dori, Chuo-ku, Fukuoka-shi, Fukuoka 810

Ikeda, T. Nuclear Engineer, JGC Corp.
1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa

Ikeda, Y. System Planning Team,
Mitsubishi Atomic Power Industries, Inc.
2-4-1, Shibakoen, Minato-ku, Tokyo

Ikuse, H. Waste Management Technology Department, Nuclear Engineering Center,
Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Imoto, K. Computational Engineering Department, Technical Research Institute,
Ohbayashi Corp.,
4-640, Shimokiyoto, Kiyose-shi, Tokyo 204

Inohara, Y. Senior Research Engineer,
Central Research Institute of Electric Power Industry,
1-6-1, Ote-machi, Chiyoda-ku, Tokyo 100

Inoue, O. Nuclear and Electric Division, Toyo Engineering Corp.,
7-7-1, Hon-cho, Funabashi-shi, Chiba 273

Inoue, Y. Staff Researcher, Mitsubishi Research Institute Inc.,
Time&Life Bldg., 2-3-6, Ote-machi, Chiyoda-ku, Tokyo 100

Isayama, Y. Nuclear Engineering Division, Ebara Corp.,
1-6-27, Kohnan, Minato-ku, Tokyo 108

Ishihara, T. Technical Advisor of RAD, Waste Management Center
2-8-10, Toramon, Minato-ku, Tokyo

Ishii, H. Deputy General Manager, Nuclear Fuel Department,
Tokyo Electric Power Co.
1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Ishii, T. Manager, Radioactive Waste Group, Nuclear Power Division,
Shimizu Corp.
Mita 43 Mori Bldg., 13F, 3-13-16, Mita, Minato-ku, Tokyo

Ishii, T. Assistant General Manager, Nuclear Energy Department,
Mitsubishi Metal Corp.,
1-38-9, Nihonbashi Kakigara-cho, Chuo-ku, Tokyo

Ishikawa, H. Chief, Decommissioning Program Management Division,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Ishikawa, H. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Ishikawa, M.	Deputy, Director General, Tokai Research Establishment, Japan Atomic Energy Research Institute, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki
Itagaki, H.	Graduate Student, Nuclear Engineering Research Laboratory, University of Tokyo 2-22, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki 319-11
Ito, T.	Nuclear Energy Department, Toa Corp. 5, Yonban-cho, Chiyoda-ku, Tokyo
Ito, Y.	Radiation Safety Control Division, Nuclear Power Plant Operation & Maintenance Department, Tokyo Electric Power Co., 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo
Iwai, M.	Manager, Nuclear Power Operation Department, Kansai Electric Power Co., Inc. 3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka
Iwase, T.	Deputy General, Second Testing Division, Radioactive Waste Management Center, No.15 Mori Bldg., 2-8-10, Toranomon, Minato-ku, Tokyo 105
Izumoji, Y.	Manager, Radiochemistry Research, Mitsubishi Atomic Power Industries, Inc., 1-297, Kitabukuro-machi, Omiya-shi, Saitama
Jinbo, Y.	General Manager, Sales Marketing Division, Tokyo Branch, Fukuda Corp., 3-26, Nonmura-cho, Ichigaya, Shinjuku-ku, Tokyo 162
Kagawa, T.	Manager, US Project Department, Nuclear and Advanced Technology Division, JGC Corp. No.7 Bldg., 1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa 232
Kai, H.	General Manager, Environment and Health Physics Department, Nuclear Fuel Industries, Ltd. 3135-41, Muramatsu, Tokai-mura, Naka-gun, Ibaraki 319-11
Kamegawa, H.	Managing Director, Chubu Electric Power Co., Inc. 1, Toshin-cho, Higashi-ku, Nagoya-shi, Aichi
Kamiya, Y.	Structural Engineer, Kumagai-Gumi Co., Ltd., 2-1, Tsukudo-cho, Shinjuku-ku, Tokyo
Kamiyama, H.	Head, Shallow Land Migration Laboratory, Japan Atomic Energy Research Institute, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki
Kamotani, N.	SAIMALEC Corp., Asahi Seimei Bldg. 9F, 1-5-1, Yuraku-cho, Chiyoda-ku, Tokyo

Karino, N. Senior Staff, Constructive & Maintenance Office,
Power Reactor and Nuclear Fuel Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Karita, Y. Manager, Nuclear R&D Section, R&D Department,
Engineering Business Group, NGK Insulators, Ltd.
1, Maegata-cho, Handa-shi, Aichi 475

Kashimura, A. General Manager, Nuclear Energy Development Division,
Kumagai Gumi Co., Ltd.,
2-1, Tsukudo-cho, Shinjuku-ku, Tokyo 162

Kashiwagi, T. Technical Consultant, Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Katano, T. Manager, Waste Management Technology Department,
Nuclear Engineering Center, Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Katsunuma, Y. Senior Staff, System Engineering Division,
Radioactive Waste Management Center,
No. 15 Mori Bldg., 2-8-10, Toranomon, Minato-ku, Tokyo 105

Kawaguchi, M. Researcher, JGC Corporation,
2205, Narita-cho, Orai-cho, Higashi-Ibaraki-gun, Ibaraki 311-13

Kawai, Y. Deputy Manager, Operating Plant Engineering Section,
Design Engineering Department, Toshiba Corp.,
8, Shinsugita-cho, Isogo-ku, Yokohama-shi, Kanagawa

Kawamura, S. Waste ManagemeNT Section, Oarai Engineering Center,
Power Reactor and Nuclear Fuel Development Corp.,
4002, Narita-cho, Oarai-machi, Higashiibaraki-gun, Ibaraki

Kawanishi, M. Senior Researcher, Central Research Institute of Electric Power Industry,
1646 Abiko, Abiko-shi, Chiba 270-11

Kawase, K. Fukushima Daini Nuclear Power Station, Tokyo Electric Power Co.
12, Kohamasaku, Namikikura, Naraha-machi, Futaba-gun, Fukushima

Kikuchi, M. Senior Engineer, Nuclear Equipment Design Department, Hitachi Works,
Hitachi, Ltd.,
3-1-1, Saiwai-cho, Hitachi-shi, Ibaraki 316

Kinoshita, K. Radioactive Waste Treatment and Decontamination Division,
Japan Atomic Energy Research Institute,
3607, Narita-cho, Oarai-machi, Higashi-Ibaraki-gun, Ibaraki 311-13

Kisaki, H. General Manager, Research & Administration Department,
Japan Nuclear Fuel Industries Co., Inc.,
1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo

Kita, S. Senior Deputy Manager, Project Department, JGC Corp.,
1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa 232

Kita, H. Nuclear Energy Department, Mitsui Construction Co., Ltd.
3-10-1, Iwamoto-cho, Chiyoda-ku, Tokyo 101

Kitamura, K. Manager, Reprocessing and Transport Contracts,
Kansai Electric Power Co., Inc.
3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Kitamura, M. Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Kiuchi, Y. Senior Engineer, Hitachi Engineering Service Co.
5-2-3, Omika-cho, Hitachi-shi, Ibaraki

Kiyose, R. Professor, Tokai University
1117, Kita-Kaname, Hiratsuka-shi, Kanagawa 259-12

Kobayashi, A. Research Engineer, Technical Research Institute, Hazama-gumi, Ltd.
4-17-23, Homachi Nishi, Yono-shi, Saitama 338

Kobayashi, H. Engineer, Power Reactor & Nuclear Fuel Development Corp.,
4-33, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Kobayashi, K. Manager, Engineering Section, Onagawa Nuclear Power Station,
Tohoku Electric Power Co., Inc.
1, Maeda, Tsukahama, Onagawa-cho, Ojika-gun, Miyagi

Kobayashi, S. General Manager, Office of Nuclear Engineering,
Takenaka Corp.,
8-21-1, Ginza, Chuo-ku, Tokyo 101

Kohno, I. General Manager, Overseas Reprocessing Committee,
Toden Annex, 1-5-1, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Kohri, M. Manager, System Engineering Department,
Mitsubishi Atomic Power Industries Inc.
2-4-1, Shibakoen, Minato-ku, Tokyo

Komatsu, F. Senior Researcher, Development Project Section, R&D Center,
Kobe Steel Ltd.
1-3-18, Wakinohama-cho, Chuo-ku, Kobe-shi, Hyogo

Komatsu, J. Managing Director,
Research Association for Nuclear Facility Decommissioning
821-100, Funaishikawa, Tokai-mura, Naka-gun, Ibaraki

Komatsu, Y. Nuclear Engineering and Equipment Department, Kobe Steel Ltd.
Tekko Bldg., 1-8-2, Marunouchi, Chiyoda-ku, Tokyo

Kondo, N. Nuclear Power Department, Toda Construction Co., Ltd.
1-7-1, Kyobashi, Chuo-ku, Tokyo

Konishi, M. Research Engineer, Tsukuba Research Institute, Okumura Corp.
387, Tsukuba-shi, Ibaraki 300-33

Konno, S. Nuclear Plant Group, Engineering Department,
Asahi Engineering Co., Ltd.,
3-25-23, Takanawa, Minato-ku, Tokyo

Konno, T. Nuclear Structure Department, Kajima Corp.,
6-5-30, Akasaka, Minato-ku, Tokyo 107

Kosaka, T. Manager, Nuclear Facilities Engineering Department, Taisei Corp.,
1-25-1, Nishi-Shinjuku, Shinjuku-ku, Tokyo 163

Kosaka, T. Reprocessing Plant Management Section,
Power Reactor and Nuclear Fuel Development Corp.
Sankaido Bldg., 1-9-13, Akasaka, Minato-ku, Tokyo 107

Koyama, H. Research Advisor,
Central Research Institute of Electric Power Industry
2-11-1, Iwato-Kita, Komae-shi, Tokyo 201

Koyanagi, N. Sub Leader, Chichibu Cement Co., Ltd.
2-1-1, Tsukimi-cho, Chichibu-shi, Saitama

Kozai, N. Research Engineer, Engineered Barrier Materials Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Kubota, M. Head, Radioactive Waste Partitioning Research Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Kuribayashi, H. Deputy General Manager, Nuclear and Advanced Technology Division,
JGC Corp.,
2-2-1, Ote-machi, Chiyoda-ku, Tokyo 100

Kusaka, S. Manager, Osaka Branch, Market Department,
Nuclear System & Equipment Division, NGK Insulators, Ltd.
Midosuji Mitsui Bldg. 11F, 4-1-3, Bingo-cho, Chuo-ku, Osaka-shi, Osaka

Kuwahara, K. Executive Director, Genshiryoku-Daiko, Ltd.,
1480, Takada, Kashiwa-shi, Chiba

Lucey, M. J. Editor, JGC Corp.,
2-2-1, Ote-machi, Chiyoda-ku, Tokyo 100

Maeda, M. Head, Fuel Reprocessing Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Maeguchi, H. Engineer, Sumitomo Metal Mining Co., Ltd.,
2600, Ishigamitojuku, Tokai-mura, Naka-gun, Ibaraki

Maekawa, K. Waste Management Technology Department, Mitsubishi Metal Corp.
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Maki, Y. Director, Central Research Institute of Electric Power Industry
1-6-1, Ote-machi, Chiyoda-ku, Tokyo 100

Makino, H. Graduate Student, Department of Nuclear Engineering,
Nagoya University,
1, Furo-cho, Chikusa-ku, Nagoya-shi, Aichi

Makino, M. Manager, RWM Project Department Nuclear and Advanced Technology Division, JGC Corp., 1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa 232

Mano, T. Radioactive Waste Management Project, Power Reactor and Nuclear Fuel Development Corporation 1-9-13, Akasaka, Minato-ku, Tokyo

Masuda, S. Radioactive Waste Management Project, Power Reactor and Nuclear Fuel Development Corporation 1-9-13, Akasaka, Minato-ku, Tokyo

Matsumi, S. Nuclear Plant Component Designing Section, Mitsubishi Heavy Industries, Ltd., 1-1-1, Wadasaki-cho, Hyogo-ku, Kobe-shi, Hyogo 652

Matsumoto, H. Deputy Manager, Nuclear Power Division, The Federation of Electric Power Companies Keidanrenkaikan Bldg., 1-9-4, Ote-machi, Chiyoda-ku, Tokyo

Matsumoto, T. Associate Professor, Hokkaido University, Kita-13, Nishi-8, Kita-ku, Sapporo-shi, Hokkaido 060

Matsunaga, Y. Nuclear Facilities Division Structure Engineer, Ohbayashi Corp., Union Bldg., 3-20, Kanda Nishiki-cho, Chiyoda-ku, Tokyo

Matsutani, K. Project Planning Section, Nuclear Project Department, Kansai Electric Power Co., Inc. 3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Matsuura, H. Senior Researcher, Nuclear Research Laboratory, Nippon Atomic Industry Group Co., Ltd., 4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Matsuzuru, H. Principal Scientist, Head, Environmental Assessment Laboratory, Japan Atomic Energy Research Institute, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Meguro, A. Manager, Nulcear Power Plant Mechanical & Instrumentation Design Dept., Toshiba Engineering & Construction Co., Ltd. 3-3-21, Isogo, Isogo-ku, Yokohama-shi, kanagawa

Mikami, T. Senior Engineer, Ohbayashi Corp., Uchiyama Bldg., 2-12-5, Uchikanda, Chiyoda-ku, Tokyo

Mitsui, T. Acting Manager, Nuclear Fuel Reprocessing Plant Engineering Department, Mitsubishi Heavy Industries, Ltd. Shuwa Shiba Park Bldg. 6F, 2-4-1, Shibakoen, Minato-ku, Tokyo 105

Mitsushima, N. General Manager, Nuclear Engineering & Equipment Department, Kobe Steel Ltd. Tekko Bldg., 1-8-2, Marunouchi, Chiyoda-ku, Tokyo

Miyagawa, T. Fukushima Daiichi Nuclear Power Station, Tokyo Electric Power Co., 22, Kitahara Ottozawa, Okuma-machi, Futaba-gun, Fukushima

Miyamoto, H. Senior Research Engineer, Takasago R&D Center,
Mitsubishi Heavy Industries, Ltd.
2-1-1, Shinhama Arai-cho, Takasago-shi, Hyogo

Miyamoto, Y. Chief, The 3rd Design Section, Atomic Power Department,
Kimura Chemical Plant Co., Ltd.
2-1-2, Terajima, Kuise, Amagasaki-shi, Hyogo

Miyao, H. Administration Division,
Power Reactor and Nuclear Fuel Development Corporation
4002, Narita-cho, Oarai-machi, Higashi-Ibaraki-gun, Ibaraki

Miyata, K. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Miyazaki, T. Engineer, New Material Research Team, Omiya Technical Institute,
Mitsubishi Atomic Power Industries, Inc.
1-297, Kitabukuro-cho, Omiya-shi, Saitama 330

Miyazaki, T. Team Leader, Information & Project Team, Nuclear Fuel Department,
Mitsubishi Corp.
2-6-3, Marunouchi, Chiyoda-ku, Tokyo 100-86

Miyazawa, M. Genreral Manager, Nuclear Facilities, Taisei Corp.,
1-25-1, Nishi-Shinjuku, Shinjuku-ku, Tokyo 163

Miyazawa, T. Senior Manager, Nuclear Engineering Laboratory, Toshiba Corp.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Mizuniwa, F. Chief Assistant of Department, Manager, Hitachi Kyowa Kogyo Co., Ltd.
3-10-2, Benten-cho, Hitachi-shi, Ibaraki 317

Mochammad, I. P. Student of Graduate Course, Department of Nuclear Engineering,
Kyoto University
Yoshida-Honcho, Sakyo-ku, Kyoto-shi, Kyoto 606

Mochizuki, H. Assistant Manager, Nuclear Fuel Department,
Tokyo Electric Power Co.,
1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Mochizuki, K. Research Engineer, Toyo Engineering Corp.
1818, Tohgo, Mobara-shi, Chiba

Mochizuki, M. Chief Chemist, Technical Research Laboratory, Takenaka Corp.,
2-5-14, Minamisuna, Koto-ku, Tokyo

Mohri, T. Manager, Chubu Environment Tech. Co.
4-14-60, Osu, Naka-ku, Nagoya-shi, Aichi

Morikawa, S. Nuclear and Adavanced Technology Division, JGC Corp.
2-2-1, Ote-machi, Chiyoda-ku, Tokyo

Morisue, T. Manager, Nuclear Engineering Laboratory, Toshiba Corp.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Moriyama, H. Instructor, Department of Nuclear Enigneering, Kyoto University
Yoshida-Honmachi, Sakyo-ku, Kyoto-shi, Kyoto 606

Moriyama, N. Principal Engineer, Tokai Research Establishment,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Morooka, K. Information & Project Team, Nuclear Fuel Department,
Mitsubishi Corp.
2-6-3, Marunouchi, Chiyoda-ku, Tokyo 100-86

Mrowicki, R. Counsellor of Atomic Energy, British Embassy
1, Ichiban-cho, Chiyoda-ku, Tokyo 102

Murabe, Y. Deputy Manager, Construction Div., Radioactive Waste Management Dept.
Japan Nuclear Fuel Industries Co., Ltd.,
Hirakawacho Daiichiseimei Bldg., 1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo

Murakoshi, T. Manager, Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Muraoka, S. Head, Engineered Barrier Materials Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Murata, T. Managing Director, Nippon Nuclear Fuel Development Co., Ltd.,
2163, Narita-cho, Oarai-machi, Higashi-Ibaraki-gun, Ibaraki 311-13

Muroi, M. Waste Management Technology Department, Nuclear Engineering Center,
Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Mutoh, S. Senior Staff, Plant Engineering Section I,
Nuclear System & Equipment Division, NGK Insulators, Ltd.
2-56, Suda-cho, Mizuho-ku, Nagoya-shi, Aichi 467

Naba, K. Director of Radiation Safety, School of Medicine, Keio University,
35, Shinano-machi, Shinjuku-ku, Tokyo 160

Nabeshima, M. Chief Chemical Engineer, Sumitomo Metal Mining Co., Ltd.
2600, Ishigamitojuku, Tokai-mura, Naka-gun, Ibaraki

Nagahara, S. Senior Engineer, Mitsui Engineering & Shipbuilding Co., Ltd.
5-6-4, Tsukiji, Chuo-ku, Tokyo

Nagano, K. Research Engineer, Economic Research Center,
Central Research Institute of Electric Power Industry
Otemachi Bldg., 1-6-1, Ote-machi, Chiyoda-ku, Tokyo 100

Nagase, T. General Manager, Engineering Department, Nuclear Power Division,
Shimizu Corp.
Mita 43 Mori Bldg. 13F, 3-13-16, Mita, Minato-ku, Tokyo

Nagino, Y. Nuclear Engineering, Ltd.
1-3-7, Tosabori, Nishi-ku, Osaka-shi, Osaka

Nakagoshi, A. Nuclear Power Department, Hazama-gumi, Ltd.
2-5-8, Kita-Aoyama, Minato-ku, Tokyo 107

Nakahara, Y. Manager, System Planning, System Engineering Department,
Mitsubishi Atomic Power Industries, Inc.
2-4-1, Shibakoen, Minato-ku, Tokyo

Nakahira, H. Manager, Marketing & Administration Department, Nuclear Energy Division,
Sumitomo Metal Mining Co., Ltd.,
5-11-3, Shinbashi, Minato-ku, Tokyo

Nakai, E. Manager, Waste Management Technology Department,
Nuclear Engineering Center, Mitsubishi Metal Corp.
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Nakajima, S. Research Scientist, Department of Environmental Safety Research,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki 319-11

Nakajima, T. Executive Vice President, JGC Corp.,
2-2-1, Ote-machi, Chiyoda-ku, Tokyo 100

Nakamasu, S. General Manager, Nuclear Engineering Department,
Konoike Construction Co., Ltd.
2-3-11, Kanda Surugadai, Chiyoda-ku, Tokyo 101

Nakamori, Y. Senior Engineer, Mitsui Engineering & Shipbuilding Co., Ltd.
5-6-4, Tsukiji, Chuo-ku, Tokyo

Nakamura, K. Hitachi Works, Hitachi, Ltd.
3-1-1, Saiwai-cho, Hitachi-shi, Ibaraki 317

Nakamura, T. Chief, Reactor Decommissioning Division I, Department of JPDR,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki 319-11

Nakanishi, Y. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Nakasaki, H. Research Manager, Technical Research Laboratory, Takenaka Corp.,
2-5-14, Minamisuna, Koto-ku, Tokyo

Nakaya, Y. Development Managing Department, Tech. Service & Coordination Division,
JGC Corp.,
1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa

Nakayama, Y. Manager, Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Niguma, Y.	Kawasaki Heavy Industroes, Ltd., 2-4-25, Minamisuna, Koto-ku, Tokyo 136
Nishihara, Y.	Nuclear Energy Systems Headquarters, Nuclear Fuel Cycle Engineering Dept., Mitsubishi Heavy Industries, Ltd. 2-4-1, Shibakoen, Minato-ku, Tokyo 105
Nishimura, M.	Graduate Student, Department of Nuclear Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya-shi, Aichi
Nishioka, M.	Technical Officer, Research Laboratory of Hydrothermal Chemistry, Kochi University 2-5-1, Akebono-cho, Kochi-shi, Kochi 780
Nohmi, M.	Manager, Nuclear Engineering Department, Ebara Corp., 4-2-1, Hon-Fujisawa, Fujisawa-shi, Kanagawa 251
Odagawa, M.	Office of Nuclear Engineering, Takenaka Corp., 8-21-1, Ginza, Chuo-ku, Tokyo 104
Ogata, Y.	Radioactive Waste Management Project, Power Reactor and Nuclear Fuel Development Corporation, 1-9-13, Akasaka, Minato-ku, Tokyo
Ogawa, M.	Manager, Nuclear Plant Sales Department, Ishikawajima-Harima Heavy Industries Co., Ltd. 1-6-2, Marunouchi, Chiyoda-ku, Tokyo
Ohe, T.	Senior Reseach Engineer, Cetral Research Institute of Electric Power Industry, 2-11-1, Iwato-Kita, Komae-shi, Tokyo 201
Ohi, T.	Waste Technology Development Division, Power Reactor and Nuclear Fuel Development Corporation Muramatsu, Tokai-mura, Naka-gun, Ibaraki
Ohki, A.	Director, Nuclear Energy Systems, The Japan Electrical Manufactures' Association 2-4-15, Nagata-cho, Chiyoda-ku, Tokyo 100
Ohno, H.	Manager, Nuclear Power Operations Department, Chubu Electric Power Co., Inc. 1, Toshi-cho, Higashi-ku, Nagoya-shi, Aichi
Ohshima, S.	Kashiwazaki Kariwa Nuclear Power Station, Tokyo Electric Power Co. 16-46, Aoyama-cho, Kashiwazaki-shi, Niigata
Ohshiro, S.	Nuclear Fuels Department, Sumitomo Corp., 3-11-1, Kanda-Nishiki-cho, Chiyoda-ku, Tokyo
Ohsono, K.	Nuclear Plant Equipment Design Section, Mitsubishi Heavy Industries, Ltd., 1-1-1, Wadasaki-cho, Hyogo-ku, Kobe-shi, Hyogo 652

Ohta, K. Manager, Nuclear Fuel Engineering Division, Nuclear Fuel Department
Shikoku Electric Power Co., Inc.
2-5, Marunouchi, Takamatsu-shi, Kagawa

Ohtake, Y. Manager, Environmental Equipment Engineering Department,
Daikin Industries, Ltd.
1-1, Nishi-Hitotsuya, Settsu-shi, Osaka

Ohuchi, M. Waste Plants Operation Division, TRU Waste Conditioning Section,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Okajima, Y. Assistant Manager, Nuclear Power Department,
Okumura Corp.
1-3-10, Motoakasaka, Minato-ku, Tokyo 107

Okamoto, H. Tokai Reprocessing Plant, Processing Division,
Power Reactor & Nuclear Fuel Development Corp.,
4-33, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Okamoto, M. Assistant Manager, Mitsubishi Metal Co.,
Miyamae Bldg., 1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo

Okishio, M. Manager, Nuclear Engineering Department, Sato Kogyo Co., Ltd.,
4-12-20, Nihonbashi-Honcho, Chuo-ku, Tokyo 103

Ono, Y. Assistant Manager, Waste Management Technology Department,
Mitsubishi Metal Corp.
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Onozawa, T. Deputy Manager, Advanced Technology Department,
Nuclear Power Engineering Test Center,
Shuwa-Kamiyacho Bldg. 2F, 4-3-13, Toranomon, Minato-ku, Tokyo 105

Onuki, T. Research Scientist, Department of Environmental Safety Research,
Japan Atomic Energy Research Institute
2, Shirakata, Shirane, Tokai-mura, Ibaraki

Onuma, M. Deputy Manager, Nuclear Fuel Cycle Project Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Ozaki, M. Research Division, Planning & Coordination Department,
Komatsu, Ltd.
1200, Manda, Hiratsuka-shi, Kanagawa 254

Ozaki, T. Research Engineer, Department of Environmental Safety Research,
Japan Atomic Energy Research Institute,
2-4, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki 319-11

Saegusa, T. Nuclear Fuel Cycle Project Team,
Central Research Institute of Electric Power Industry
1-6-1, Ote-machi, Chiyoda-ku, Tokyo 100

Sagawa, H. System Engineering&Development Team, System Engineering Department,
Mitsubishi Atomic Power Industries, Inc.
Shuwa Shiba Park Bldg., 2-4-1, Shibakoen, Minato-ku, Tokyo

Saido, K. President, CEO, IEA of Japan Co., Ltd.
Sumitomo Higashi-Shinbashi Bldg. No.4, Shinbashi 6-9-6, Shinbashi, Minato-ku, Tokyo 105

Saito, M. Section Assistant Manager, Nuclear Planning Department, Kansai Electric Power Co., Inc.
3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Saito, N. Waste Technology Development Division, Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Saito, S. Manager, Nuclear Power Safety Section, Nuclear Power Department, Tohoku Electric Power Co., Inc.
3-7-1, Ichiban-cho, Aoba-ku, Sendai-shi, Miyagi

Sakai, A. Assistant Manager, Nuclear Fuel Cycle Systems Design Department, Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Sakai, K. Assistant General Manager, Plant Engineering Department, Japan Atomic Power Co.
1-6-1, Ote-machi, Chiyoda-ku, Tokyo

Sakamoto, H. Chichibu Cement Co., Ltd.
2-1-1, Tsukimi-cho, Kumagaya-shi, Saitama

Sakamoto, S. Engineer, Nuclear Engineering Laboratory, Toshiba Corp., 4-1, Ukishima-cho, kawasaki-ku, Kawasaki-shi, Kanagawa 210

Sakata, H. Advisor, Sato Kogyo Co., Ltd.
4-12-20, Hon-cho Nihonbashi, Chuo-ku, Tokyo 103

Sakuma, H. Radioactive Waste Management Project, Power Reactor and Nuclear Fuel Development Corporation
1-9-13, Akasaka, Minato-ku, Tokyo

Sakurai, D. Senior Manager, New Plant Business Development Division, Nippon Steel Corp.,
2-6-3, Ote-machi, Chiyoda-ku, Tokyo

Sakurai, H. Technical Advisor, Chuo Kaihatsu Corp. International
3-12-3, Nishi-Waseda, Shinjuku-ku, Tokyo

Sakuramoto, N. Senior Staff, Nuclear R&D Section, R&D Department, Engineering Business Group, NGK Insulators, Ltd.
1, Maegata-cho, Handa-shi, Aichi 475

Sampei, T. Environment and Health Physics Department, Nuclear Fuel Industries, Ltd.
3135-41, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Sano, Y. Deputy Manager, Nuclear Engineering Laboratory, Toshiba Corp., 4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Sasaki, N. Radioactive Waste Management Department, Construction Division, Japan Nuclear Fuel Industries Co., Ltd.
Hirakawacho-Daiichiseiemi Bldg., 1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo

Sasaki, N. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Sasaki, N. Chemical System Engineering Section, System Equipment Engineering Dept.,
Toshiba Corp.,
8, Shinsugita-cho, Isogo-ku, Yokohama-shi, Kanagawa 235

Sasaki, S. Deputy General Manager, Nuclear Power Administration
Tokyo Electric Power Co.
1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Sasoh, M. Research Staff Scientist, Nuclear Research Laboratory,
Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Sato, S. Research Associate, Department of Nuclear Engineering,
Kyushu University,
6-10-1, Hakozaki, Higashi-ku, Fukuoka 812

Sawauchi, Y. Chief, Civil Engineeirng Design Division, Kajima Corp.,
6-5-30, Akasaka, Minato-ku, Minato-ku, Tokyo 107

Segawa, S. Decommissioning Waste Management Division, Department of JPDR,
Japan Atomic Energy Research Institute,
Shirakata Shirane, Tokai-mura, Naka-gun, Ibaraki 311-19

Seki, K. Manager, Nuclear Power Operation Department,
Kansai Electric Power Co., Inc.
3-3-22, Nakanohima, Kita-ku, Osaka-shi, Osaka

Seki, S. Research Scientist, Nuclear Research Laboratory,
Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Seki, Y. Executive Nuclear Consultant, Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Senda, Y. Direcotr & General Manager, Nuclear System & Equipment Division,
NGK Insulators, Ltd.
2-56, Suda-cho, Mizuho-ku, Nagoya-shi, Aichi 467

Senoo, M. Senior Engineer, Engineered Barrier Materials Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Seo, T. Waste Isolation Research Section,
Power Reactor and Nuclear Fuel Development Corporation,
959-31, Sonodo, Jorinji, Izumi-cho, Toki-shi, Gifu

Shibutani, H. Technical Section, Casting Department, Kobe Cast Iron Works, Ltd.,
3-12, Kanbei-cho, Otsu-ku, Himeji-shi, Hyogo

Shimabe, K. Assistant Manager, Nuclear Power Department, Hazama-gumi, Ltd.
2-5-8, Kita-Aoyama, Minato-ku, Tokyo 107

Shimamura, O. Manager, Tech. Section, 2nd Kanto Storage Station of Radioactive Waste,
Japan Radioisotope Association,
506, Mizusuna Toyofuna, Kashiwa-shi, Chiba

Shimoda, H. Director and General Manager, Radioactive Waste Management Department,
Japan Nuclear Fuel Industries Co., Ltd.,
Hirakawacho-Daiichiseimei Bldg., 1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo

Shimodaira, C. General Manager, Chiyoda Corp.,
2-12-1, Tsurumi-Chuou, Tsurumi-ku, Yokohama-shi, Kanagawa

Shimokawa, H. Director, The Japan Atomic Power Co.
Otemachi Bldg., 1-6-1, Ote-machi, Chiyoda-ku, Tokyo

Shimokawa, J. Advisor, Mitsui Construction Co., Ltd.,
3-10-1, Iwamoto-cho, Chiyoda-ku, Tokyo 101

Shimooka, K. Researcher, Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Shiogama, Y. Research Engineer, Civil Engineering Department,
Kajima Institute of Construction Technology, Kajima Corp.,
2-19-1, Tobitakyu, Chofu-shi, Tokyo

Shiotsuki, M. Administration Division,
Power Reactor and Nuclear Fuel Development Corporation,
4002, Narita-cho, Orai-machi, Higashi-Ibaraki-gun, Ibaraki

Shirai, T. Senior Research Scientist, Nuclear Research Laboratory,
Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Shirato, K. Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Shoji, Y. Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Shuto, M. General Manager, Reprocessing Project Deparment,
Sumitomo Metal Mining Co., Ltd.,
5-11-3, Shinbashi, Minato-ku, Tokyo

Sugai, K. Radiation Safety Control Division,
Nuclear Power Plant Operation & Maintenance Department,
Tokyo Electric Power Co., 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo

Sugai, H. Assistant Chief Engineer, Sumitomo Metal Mining Co., Ltd.,
2600, Ishigamitojuku, Tokai-mura, Naka-gun, Ibaraki

Sugiura, N. Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Sukegawa, T. Chief, Decommissioning Waste Management Division, Department of JPDR, Japan Atomic Energy Research Institute, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Suzuki, A. Professor, Department of Nuclear Engineering, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113

Suzuki, S. Waste Isolation Ore Processing Division, Power Reactor and Nuclear Fuel Development Corporation, 1550, Kamisaihara-mura, Tomada-gun, Okayama

Tada, H. Director of Special Project, Nuclear Fuel Industries, Ltd. Higobashi-Shimizu Bldg., 1-3-7, Tosabori, Nishi-ku, Osaka-shi, Osaka

Takada, A. Nuclear Instrumentation Section, Toshiba Engineering & Construction Co., Ltd. 3-3-21, Isogo, Isogo-ku, Yokohama-shi, Kanagawa 235

Takahara, A. Energy & Electric Power Division, Toyo Engineering Corp. 3-2-5, Kasumigaseki, Chiyoda-ku, Tokyo

Takahashi, A. Deputy General Manager, Nuclear Energy Department, Nissho Iwai Corp. 2-4-5, Akasaka, Minato-ku, Tokyo

Takahashi, K. Engineer, Central Research Institute of Electric Power Industry, 2-11-1, Iwato-Kita, Komae-shi, Tokyo 201

Takahashi, T. Graduate Student, Department of Environmental & Sanitary Engineering, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto-shi, Kyoto 606

Takahashi, T. Waste Technology Development Division, Power Reactor and Nuclear Fuel Development Corporation, Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Takahashi, T. Radioactive Waste Management Project, Power Reactor and Nuclear Fuel Development Corporation, 1-9-13, Akasaka, Minato-ku, Tokyo

Takahashi, Y. Deputy Manager, Engineering Section, Plant Engineering Department, Japan Atomic Power Co. 1-6-1, Ote-machi, Chiyoda-ku, Tokyo

Takaoku, Y. Nuclear Business Development Division, Technical Department, Sumitomo Heavy Industries, ltd. 1, Kanda Mitoshiro-cho, Chiyoda-ku, Tokyo 101

Takebe, S. Researcher, Shallow Land Migration Laboratory, Japan Atomic Energy Research Institute, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Takeda, S. Waste Isolation Research Section,
Power Reactor and Nuclear Fuel Development Corporation,
959-31, Sonodo, Jorinji, Izumi-cho, Toki-shi, Gifu

Takeuchi, E. General Manager, Nuclear Power Operations Department,
Chubu Electric Power Co., Inc.
1, Toshin-cho, Higashi-ku, Nagoya-shi, Aichi

Takeuchi, M. Deputy Manager, Radiactive Waste Management Department,
Japan Nuclear Fuel Industries Co., Ltd.,
Hirakawacho-Daiichiseimei Bldg., 1-2-10, Hirakawa-cho, Chiyoda-ku, Tokyo

Takeuchi, S. Section Manager, Nuclear Planning Department,
Kansai Electric Power Co., Inc.
3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Takishita, T. Manager, Nuclear Fuel Cycle Department,
Shikoku Electric Power Co., Inc.
2-5, Marunouchi, Takamatsu-shi, Kagawa

Tamai, H. Manager, Fuel Cycle Systems, 2nd Nuclear Energy Systems Department,
Mitsubishi Heavy Industries, Ltd.,
2-5-1, Marunouchi, Chiyoda-ku, Tokyo 100

Tamai, T. Chief Engineer, Nuclear Power Division,
Ishikawajima-Harima Heavy Industries Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Tanaka, E. Nuclear Structures Department, Kajima Corp.,
6-5-30, Akasaka, Minato-ku, Tokyo 107

Tanaka, H. Principal Research Engineer,
Central Research Institute of Electric Power Industry
1-6-1, Ote-machi, Chiyoda-ku, Tokyo 100

Tanaka, K. Waste Plants Operation Division, Low Level Waste Conditioning Section,
Power Reactor and Nuclear Fuel Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Tanaka, K. Assistant Manager, Nuclear Power Department, Kajima Corp.,
6-5-30, Akasaka, Minato-ku, Tokyo

Tanaka, M. General Manager, Decommissioning Technology Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Tanaka, R. Manager, Nuclear Power Operations Department,
Chubu Electric Power Co., Inc.
1, Toshin-cho, Higashi-ku, Nagoya-shi, Aichi

Tanaka, S. Associate Professor, Nuclear Engineering Research Laboratory,
University of Tokyo
2-22, Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki 319-11

Tanaka, T. Senior Researcher, Nuclear Plant Laboratory, NKK Co.,
1-1, Minamiwatarida-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210

Tanaka, Y. Researcher, Central Research Institute of Electric Power Industry,
1646, Abiko, Abiko-shi, Chiba 270-11

Tanaka, Y. Section Manager, Chiyoda Corp.
2-12-1, Tsurumi-Chuo, Tsurumi-ku, Yokohama-shi, Kanagawa

Taniguchi, S. General Manager, Marketing & Administration Department,
Sumitomo Metal Mining Co., Ltd.,
5-11-3, Shinbashi, Minato-ku, Tokyo

Taniuchi, H. Nuclear Group, Machinery Division, Kobe Steel, Ltd.
2-3-1, Araicho-Shinhama, Takasago-shi, Hyogo

Tasaka, H. Assistant Manager, Mitsubishi Metal Co.,
Miyamae Bldg., 1-38-9, Kakigara-cho Nihonbashi, Chuo-ku, Tokyo

Tashiro, S. General Manager, Fuel Examination Engineering Division,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Terada, S. Reprocessing Plant Engineer, Mitsubishi Heavy Industries, Ltd.
1-1-1, Wadasaki-cho, Hyogo-ku, Kobe-shi, Hyogo

Tokura, T. Deputy General Manager, Nuclear System & Equipment Division,
NGK Insulators, Ltd.
2-56, Suda-cho, Mizuho-ku, Nagoya-shi, Aichi 467

Tominaga, S. Assistant Manager, Plant Construction Section,
Chugoku Electric Power Co., Inc.
4-33, komachi, Naka-ku Hiroshima-shi, Hiroshima

Tomitaka, M. Engineer, Reprocessing Project Department, Nuclear Energy Division,
Sumitomo Metal Mining Co., Ltd.,
5-11-3, Shinbashi, Minato-ku, Tokyo

Tomura, H. General Manager, Engineering Department, Nuclear Facilities Division,
Ohbayashi Corp.,
Ryumeikan Bldg. 11F, 3-4, Kanda-Surugadai, Chiyoda-ku, Tokyo 101

Torata, S. Technology Development Co-ordination Division,
Power Reactor and Nuclear Fuel Development Corporation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Toyohara, M. Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Tsuboi, A. Assistant Manager, Nuclear Fuel SectionIII, Marubeni Corp.,
1-4-2, Ote-machi, Chiyoda-ku, Tokyo

Tsuboya, T. Radioactive Waste Management Project,
Power Reactor and Nuclear Fuel Development Corporation,
1-9-13, Akasaka, Minato-ku, Tokyo

Tsukada, T. Research Engineer, Central Research Institute of Electric Power Industry
2-11-1, Iwato-Kita, Komae-shi, Tokyo 201

Tsukamoto, M. Senior Research Chemist,
Central Research Institute of Electric Power Industry,
2-11-1, Iwato-Kita, Komae-shi, Tokyo 201

Tsunoda, N. Director, Nuclear Cycle Engineering Division,
Power Reactor and Nuclear Fuel Development Corporation,
1-9-13, Akasaka, Minato-ku, Tokyo

Tsurugi, T. Senior Staff, Nuclear Power Plant Engineering & Construction Section,
Chubu Electric Power Company, Inc.
1, Toshin-cho, Higashi-ku, Nagoya-ku, Aichi

Tsutsumi, M. Manager, First Testing Division,
Radioactive Waste Management Center,
No.15 Mori Bldg., 2-8-10, Toranomon, Minato-ku, Tokyo 105

Uchida, S. Senior Researcher, National Institute of Radiological Sciences,
3609, Isozaki, Nakaminato-shi, Ibaraki 311-12

Uchiyama, G. Researcher, Fuel Reprocessing Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Uchiyama, K. Assistant Manager, Nuclear Energy Development Division,
Kumagai Gumi Co., Ltd.,
2-1, Tsukudo-cho, Shinjuku-ku, Tokyo 162

Ueda, S. Chief Engineer, Mitsubishi Metal Corp.,
1002-14, Mukohyama, Naka-machi, Naka-gun, Ibaraki

Umeda, K. Business Develoment Division II, Chiyoda Corp.
2-31-19, Shiba, Minato-ku, Tokyo

Urabe, N. Manager, NKK Corp.,
1-1, Minamiwatarida, Kawasaki-ku, Kawasaki-shi, Kanagawa

Uragami, M. Research Engineer, Decommissioning Technology Laboratory,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Wada, T. Nuclear Fuel Cycle Department, Nuclear Power Generation Division
Hitachi, Ltd.
Kandasurugadai, Chiyoda-ku, Tokyo

Wada, Y. Deputy Manager, Innovation Technology Development Section,
Power Reactor and Nuclear Fuel Development Corportation,
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Wakamatsu, H. Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Wakui, H. Assistant General Manager, Chiyoda Corp.
2-12-1, Tsurumi-Chuo, Tsurumi-ku, Yokohama-shi, Kanagawa

Watanabe, K. Associate Professor, Faculty of Engineering,
Saitama University,
255, Shimo-Okubo, Urawa-shi, Saitama 338

Watanabe, M. Manager, Engineering Department, Nuclear Power Division,
Shimizu Corp.
Mita 43 Mori Bldg. 13F, 3-13-16, Mita, Minato-ku, Tokyo

Watanabe, S. Assistant Chief Engineer, Nuclear Fuel Cycle Engineering Department,
Mitsubishi Heavy Industries, Ltd.,
Shuwa Shiba Park Bldg., 2-4-1, Shibakoen, Minato-ku, Tokyo 105

Watanabe, T. Graduate Student, Department of Nuclear Engineering,
Nagoya University,
Furo-cho, Chikusa-ku, Nagoya-shi, Aichi

Wataru, M. Assistant Research Engineer,
Central Research Institute of Electric Power Industry,
1646, Abiko, Abiko-shi, Chiba 270-11

Wisnubroto, D. S. Graduate School Student, Department of Nuclear Engineering,
University of Tokyo,
7-3-1, Hongo, Bunkyo-ku, Tokyo 113

Yagi, T. Manager, Technology Development Department, JGC Corp.,
1-14-1, Bessho, Minami-ku, Yokohama-shi, Kanagawa 232

Yahata, T. Radioactive Waste Treatment and Decontamination Division,
Japan Atomic Energy Research Institute,
3607, Narita-cho, Oarai-machi, Higashi-Ibaraki-gun, Ibaraki 311-13

Yamada, A. Manager, Nuclear Fuel Cycle Section, Nuclear Department,
Chugoku Electric Power Co., Inc.
4-33, Komachi, Naka-ku, Hiroshima-shi, Hiroshima

Yamada, K. Researcher, Reactor Chmistry Department, Nuclear Research Laboratory,
Nippon Atomic Industry Group Co., Ltd.,
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa

Yamada, M. General Manager, Nuclear Fuels Department, Sumitomo Corp.
3-11-1, Kandanishiki-cho, Chiyoda-ku, Tokyo

Yamagata, J. Nuclear Fuel Cycle Systems Design Department,
Ishikawajima-Harima Heavy Industires Co., Ltd.
1, Shinnakahara-cho, Isogo-ku, Yokohama-shi, Kanagawa

Yamaguchi, T. Student, Kyoto University
Yoshida-Honcho, Sakyo-ku, Kyoto-shi, Kyoto

Yamaguchi, Y. Senior Engineer, Toyo Engineering Corp.,
7-7-1, Honcho, Funabashi-shi, Chiba

Yamaguchi, S. Senior Specialist, Chemical System Engineering Section,
Toshiba Corp.,
8, Shinsugita-cho, Isogo-ku, Yokohama-shi, Kanagawa 235

Yamakawa, M. Waste Isolation Research Section,
Power Reactor and Nuclear Fuel Development Corporation,
959-31, Sonodo, Jorinji, Izumi-cho, Toki-shi, Gifu

Yamamoto, A. Nuclear Reactor Engineering Section, Hitachi Engineering Co., Ltd.
3-2-1, Saiwai-cho, Hitachi-shi, Ibaraki 317

Yamamoto, I. Associate Professor, Department of Nuclear Engineering,
Nagoya University,
Furo-cho, Chigusa-ku, Nagoya-shi, Aichi 464-01

Yamamoto, K. Manager, Plant Engineering Section I,
Nuclear System & Equipment Division, NGK Insulators, Ltd.
2-56, Suda-cho, Mizuho-ku, Nagoya-shi, Aichi 467

Yamamoto, K. Deputy Manager, Plant Operation Section, Tsuruga NPS,
Japan Atomic Power Co.
Myojin-cho, Tsuruga-shi, Fukui

Yamamoto, M. Radioactive Waste Management Project,
Power Reactor and Nuclear Fuel Development Corporation,
1-9-13, Akasaka, Minato-ku, Tokyo

Yamamoto, T. Manager, Nuclear Engineering & Equipment Department, Kobe Steel Ltd.
1st Tekko Bldg., 1-8-2, Marunouchi, Chiyoda-ku, Tokyo

Yamamoto, Y. President, Institute of Applied Energy
1-14-2, Nishi-Shinbashi, Minato-ku, Tokyo

Yamasaki, T. Manager in charge of Engineering, Takenaka Corp.,
8-21-1, Ginza, Chuo-ku, Tokyo 104

Yamashita, A. Special Staff, Nuclear Back-end Promotion Office, Atomic Energy Bureau,
Scientific and Technological Agency
2-2-1, Kasumigaseki, Chiyoda-ku, Tokyo 100

Yamashita, Y. Chief Engineer, Nuclear Engineering Division,
Mitsubishi Heavy Industries, Ltd.
Shuwa Shiba Park Bldg., 2-4-1, Shiba-Koen, Minato-ku, Tokyo

Yamate, K. Assistant Manager, Reprocessing Affairs, Nuclear Fuel Department,
Kansai Electric Power Co., Inc.
3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Yamauchi, J. Deputy General Manager, Technical Research & Development Division,
Nishimatsu Construction Co., Ltd.
2570-4, Shimotsuruma, Yamato-shi, Kanagawa

Yamazaki, H. Vice General Manager, Nuclear Facilities Division,
Ohbayashi Corp.,
Ryumeikan Bldg. 11F, 3-4, Kanda-Surugadai, Chiyoda-ku, Tokyo 101

Yanagi, T. Associate Professor, Department of Nuclear Engineering,
Osaka University
2-1, Yamadaoka, Suita-shi, Osaka

Yanagisawa, Y. Lead Research Engineer, Toyo Engineering Corp.
1818, Fujimi Togo, Mobara-shi, Chiba

Yasunaka, H. General Manager, Decommissioning Waste Management Division,
Japan Atomic Energy Research Institute,
Shirakata-Shirane, Tokai-mura, Naka-gun, Ibaraki

Yokoyama, H. Department Manager in charge of Nuclear Power, Kobe Steel, Ltd.
1-8-2, Marunouchi, Chiyoda-ku, Tokyo

Yokoyama, K. Researcher, JGC Corp.,
2205, Narita-cho, Oarai-machi, Higashi-Ibaraki-gun, Ibaraki 311-13

Yoshida, H. Chief Research Engineer, Kajima Institute of Construction Technology,
Kajima Corp.,
2-19-1, Tobitakyu, Chofu-shi, Tokyo

Yoshida, K. Manager of Special Assignment, Nuclear Fuel Department,
The Kansai Electric Power Co., Inc.
3-3-22, Nakanoshima, Kita-ku, Osaka-shi, Osaka

Yoshihara, K. Manager, Waste Management Technology Department,
Nuclear Engineering Center, Mitsubishi Metal Corp.,
1-38-9, Kakigara-cho, Nihonbashi, Chuo-ku, Tokyo 103

Yoshioka, M. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

Yusa, Y. Waste Technology Development Division,
Power Reactor and Nuclear Fuel Development Corporation
Muramatsu, Tokai-mura, Naka-gun, Ibaraki

ENCLOSURE 2

PRESENTATION TO THE NUCLEAR REGULATORY COMMISSION

By Leo P. Duffy

Director of the Office
of Environmental Restoration and
Waste Management and Special Assistant
to the Secretary of Energy for
Coordination of DOE Waste Management

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The purpose of this presentation is to brief the Nuclear Regulatory Commission on the present status of the Civilian Radioactive Waste Management Program, including recent accomplishments, new initiatives, and specific recommendations to enhance our interactions.

As will be discussed later in more detail, the Department believes that some progress has been made in the program over the past year. However, we do continue to be impeded by the State of Nevada's refusal to process our permit applications so we can get on with the job of characterizing the Yucca Mountain site, as required by the Nuclear Waste Policy Act, as amended. Nevertheless, progress is being made. But, before discussing specific program accomplishments, we would first like to address the new initiative recently undertaken by the Secretary of Energy with respect to the refocusing of this program.

1. SECRETARY'S REVIEW OF THE PROGRAM

The Secretary of Energy has recently completed an extensive review of the Civilian Radioactive Waste Management Program and has concluded that the program cannot be effectively executed in its present form. The Secretary recognizes that the program is technically and institutionally unprecedented. Consequently, the Secretary is committed to ensuring that a thorough and iterative scientific investigation be the focal point of the program to ensure that the results are technically sound and uncoupled from a scheduling process that constrains the time required for gathering sufficient information.

As a result of his review, the Secretary has initiated a management action plan consisting of five major elements:

- Formalizing the schedule.
- Restructuring of the Office of Civilian Radioactive Waste Management.
- Initiatives to gain access to the Yucca Mountain site to continue the scientific investigations needed to

evaluate the site's suitability for a repository.

- An initiative for establishing integrated monitored retrievable storage (MRS) with a target for spent fuel acceptance in 1998.

- Accountability for performance.

The principal elements of this plan are outlined in a report that the Department recently submitted to the Congress. A draft schedule of the revised program was also submitted with the report for comment. Copies of the report and draft schedules were also provided to the Nuclear Regulatory Commission, to the State of Nevada, and various other stakeholders in the program. The essence of this program was announced a few weeks ago by Deputy Secretary Henson Moore at the ANS/NEF meeting in San Francisco on November 28, 1989. The implementation of the plan will be described in a revised Mission Plan, which the Department plans to issue in draft form by June 1990. The following sections describe the plan in more detail.

1.1 MANAGEMENT

The Department has taken a number of steps to establish an improved management structure and procedures for the Office of Civilian Radioactive Waste Management (OCRWM).

1.1.1 NEW OCRWM DIRECTOR

The OCRWM has been headed by acting directors for the past two years. The Secretary has chosen a candidate for the OCRWM Director and has submitted his nomination to the White House. It is expected that the nomination will be submitted to the Senate for confirmation when the Congress reconvenes in January 1990.

1.1.2 DIRECT-LINE REPORTING

The Department has recently established direct-line reporting from the Yucca Mountain Project Office to OCRWM. Previously, the Project Office manager received policy guidance and technical direction from Headquarters but reported administratively to his Operations Office manager, who reports to the Under Secretary. Direct reporting will bring together authority, responsibility, and accountability, and facilitate coordination and communication.

1.1.3 QUALITY ASSURANCE PROGRAM

A quality assurance program that meets the requirements of the Nuclear Regulatory Commission has been established. Much effort this year has been devoted to the preparation and issuance

of quality assurance procedures, the training of DOE and contractor staff, and qualification audits performed to determine ability to implement the procedures. In this effort, the Department has been working closely with the NRC staff, including bimonthly meetings. As a result, more than 1,000 persons working for eight major program participants have received the required training and are now working under NRC-accepted program plans. When the remaining qualification audits of Los Alamos National Laboratories (LANL), Yucca Mountain Project Office (YMPO), and Office of Civilian Radioactive Waste Management are completed by August 1990, a quality assurance program that has been fully qualified and accepted by the NRC will be in place. Additional details regarding program accomplishments in the quality assurance area will be discussed later in this presentation (Section 2).

1.1.4 ESTABLISHMENT OF BASELINES

Technical, cost, and schedule baselines are being established to define the criteria and objectives against which program performance and progress can be measured, thus facilitating effective program control. The technical baseline, which is currently under revision, includes the functional and technical requirements at the program level. These requirements are being put into final form for issuance over the next several months. This will eventually lead to the development of specifications and designs for system elements and subsystems, evaluations of the specifications and designs against the requirements, and the refinement of the requirements.

1.1.5 DEVELOPMENT OF A REALISTIC SCHEDULE

The Secretary's comprehensive program review has included a detailed reevaluation of the overall program schedule--that is, the schedule for the repository, the MRS facility, and the transportation program. This effort consisted of a detailed examination of the duration postulated for each specific activity with emphasis on critical-path, near-critical-path, and other major activities. The results of this reevaluation are summarized in Figure 1. In addition to this summary figure, the report to Congress included two attachments showing more detailed schedules. One is a schedule showing significant milestones through the submittal of the license application for the repository, and the other is the near-term decision plan, which extends through 1990. The Department has asked for comment on these schedules, and will be particularly interested in the Commission's comments. This represents the first formal modification of the program schedule baseline since mid-1987.

1.1.5.1 Schedule for the repository

The Secretary's review of the program has led to the

development of a more realistic schedule that is based on past experience and on the detailed information developed for the Site Characterization Plan. This detailed information led to a more complete understanding of the activities to be conducted during site characterization and how long they are likely to take. As a result, the date for submitting the repository license application to the NRC is now October 2001, nearly seven years later than the previously scheduled submittal date of January 1995, and the start of repository operations is revised from the year 2003 to 2010.

1.1.5.1.1 Assumptions

The milestones in the schedule have been defined as rigorously as possible, but it must be recognized that certain activities are beyond our control. In the case of these milestones, certain assumptions were made. One such assumption was the date for obtaining the permits necessary for new scientific investigations to begin. It was assumed that these surface-disturbing new scientific investigations would begin in January 1991. This date assumes that the Department will be successful in the options it has decided to pursue to gain access to the site.

1.1.5.1.2 New focus

A cornerstone of the repository schedule is a new focus on the early evaluation of the suitability of the Yucca Mountain site. Instead of beginning site characterization with a total system approach directed at evaluating the performance of engineered barriers as well as the site and based to a large extent on underground testing, this evaluation will focus first on certain particular features of the site that can be investigated through surface-based testing. The revised schedule also recognizes that the duration of the scientific investigations, especially the later investigations conducted in the exploratory shafts and the underground testing facility, will be considerably longer than previously expected, thereby resulting in the revised license application submittal date of 2001, assuming the site is suitable.

1.1.5.1.3 Initiatives for improving the schedule

The Department remains committed to seeking ways to improve the schedule while satisfying all technical and regulatory requirements. With this objective in mind, the Department has initiated a study of alternative strategies for complying with the NRC requirements in 10 CFR Part 60. Each alternative licensing strategy will consist of an approach to determining site suitability, a general plan for meeting the licensing requirements, and priorities for testing to support the site suitability determination. It is too early to discuss these

strategies in any detail, but the Department intends to work closely with the NRC and others in their development.

During the pre-licensing phase, the Department intends to continue and to intensify its interactions with the NRC in order to reduce the number of unresolved issues, which should enhance confidence that the license application can be reviewed in three years, as called for in the Nuclear Waste Policy Act. Some DOE thoughts are offered later on how the NRC/DOE interactions can be improved.

1.1.5.2 Schedule for the MRS facility

The reference schedule for the MRS facility assumes that a site will be obtained through the efforts of the Nuclear Waste Negotiator and that the statutory linkages, specified in the Nuclear Waste Policy Amendments Act between the MRS facility and the repository are modified. Under these assumptions, it is estimated that waste acceptance at an MRS site could begin, on a limited basis, as early as January 1998; and a full-capability MRS facility that would store spent fuel as needed, for subsequent shipment to the repository, would be available in the year 2000.

If a site cannot be obtained through the Negotiator but is selected through a DOE-directed siting process and the current statutory linkages are modified, it is estimated that about 2 more years would be added, with the full-capability MRS facility starting operations in 2002. If the current statutory linkages to the repository are maintained, an additional delay of 5 years would result, with startup estimated at 2007 for the full-capability MRS facility. As is discussed later, the Department intends to pursue an initiative aimed at modifying the linkages.

There are a number of approaches we are considering to expedite spent fuel acceptance at the MRS facility. One way is to start operations with the use of transportable storage casks. These casks would be loaded at the reactor site, used to transport the spent fuel to the MRS site, and also used to provide temporary storage at the MRS site. The same casks might then be used for transportation of spent fuel to the repository once it is available. If this approach were implemented it would require NRC certification of the design of the casks under the transportation regulations in 10 CFR Part 71 and also to license their use for storage under 10 CFR Part 72. A review of these two regulations is needed to ensure compatibility and to see if the licensing process could be streamlined. The Department is examining a number of options for expediting spent fuel acceptance at the MRS facility. Key to acceptance in 1998 will be expedited licensing of the simplest possible MRS facility. Again, as our plans mature, we will discuss the various approaches we are considering with the NRC.

1.1.6 NUCLEAR WASTE NEGOTIATOR

The Secretary is working in close cooperation with the White House to facilitate the appointment of the Nuclear Waste Negotiator as provided for in the Amendments Act. The Negotiator is expected to provide valuable assistance in siting the MRS facility and facilitating the repository program.

1.2 SCIENTIFIC INVESTIGATION OF YUCCA MOUNTAIN

1.2.1 SITE ACCESS

An important factor in the near-term plans for scientific investigations at Yucca Mountain is the willingness of the State of Nevada to process the DOE applications for environmental permits. However, on November 1, 1989, the State Attorney General issued an opinion that the State had disapproved the site within the meaning of Section 115 of the Nuclear Waste Policy Act and that State agencies considering environmental permits should disregard such applications from DOE. While cooperation and direct negotiation with the State of Nevada is the preferred approach to expediting scientific investigations, the Department will pursue all available options to facilitate the timely determination of site suitability. Accordingly, the Secretary has requested that the Department of Justice initiate litigation to declare Nevada's actions invalid. Furthermore, the Department is hopeful that the permitting process could be expedited through the efforts of the Negotiator once he or she is appointed.

1.2.2 DELAY IN SHAFT CONSTRUCTION

As mentioned before, the Department has decided to focus initially on surface-based testing aimed specifically at evaluating whether the site has any features or conditions so adverse to performance that the site would not likely be able to meet the DOE's and NRC's requirements and would therefore not be suitable for a repository. Accordingly, the construction of exploratory shafts is delayed until at least 1992. This will allow the Department to carefully reevaluate, in accordance with all applicable quality assurance and NRC requirements, the locations chosen for the two exploratory shafts, the method chosen (drilling and blasting or mechanical mining) for the construction of the shafts, the means of access (ramps or shafts) to the repository horizon, the need for additional exploratory drifts, and the design of the shafts and other components of the exploratory shaft facility. Concerns regarding the shaft location and designs have come from the NRC staff, while the suggestions to reconsider the means of access, the shaft construction method, and the need for additional drifts came from the Nuclear Waste Technical Review Board. Due to this reevaluation effort, it is not expected that detailed design of

the exploratory shaft facility can start until at least in early 1991.

1.2.3 DEFERRAL OF MAJOR SITE-SPECIFIC DESIGN ACTIVITIES

Major activities related to the design of a repository at the Yucca Mountain site and the waste package are being deferred. The objective is to proceed with surface-based tests for evidence of site unsuitability, and to proceed with design, if appropriate. This approach will conserve resources and allow the Department to concentrate its efforts on scientific investigations.

1.3 MONITORED RETRIEVABLE STORAGE

In its November 1, 1989 report to the Congress, the MRS Review Commission found that "cumulatively the advantages of an MRS would justify the building of an MRS if: (1) there were no linkages between the MRS and the repository; (2) the MRS could be constructed at an early date; and (3) the opening of the repository were delayed considerably beyond its presently scheduled date of operation." The MRS Review Commission recommended that the Congress authorize the construction of a Federal Emergency Storage facility with a capacity limit of 2,000 metric tons of uranium; authorize the construction of a User-Funded Interim Storage facility with a capacity limit of 5,000 metric tons of uranium; and reconsider the need for additional interim storage in the year 2000. Thus, the Department and the MRS Review Commission agree as to the necessity for a facility that would provide storage before permanent geologic disposal, but we differ on the storage capacity required and the appropriate funding mechanism.

The Department considers that an integral MRS facility is critical to achieving timely acceptance of spent fuel and to meeting other strategic objectives, such as timely disposal, schedule confidence, and system flexibility. The Department recognizes that the advantages of the MRS facility would be more fully realized if the linkages to the repository were modified. The Department has also expressed preference for an MRS facility sited through the efforts of the Negotiator, especially if these siting negotiations lead to modified linkages.

The importance of an integral MRS facility to the waste-management system is underscored by schedule delays and the uncertainties inherent in the development of a geologic repository. As already stated, an MRS facility could start operations as early as 1998 and is a key component in the strategy for building confidence in the program.

Accordingly, the Department is pursuing several courses of action that we believe are consistent with the conclusions of the

MRS Review Commission. First, the Department will work with the Congress to modify current linkages and constraints on the MRS facility. The Amendments Act prohibits the selection of an MRS site through a DOE-directed site-survey process until the repository site is selected. However, the Amendments Act allows for expedited siting to proceed via the Negotiator. How rapidly a negotiated MRS facility can come on line and how much spent fuel it can store will depend on the negotiated agreement, which must be approved by Congress. In principle, a negotiated agreement represents an effective way of developing the facility and should allow the MRS advantages to be more fully realized. Moreover, a negotiated site could address the institutional issues earlier and more completely than were it to be associated with a siting process directed by the DOE. The Department will be ready to do whatever is necessary to help the Negotiator to respond quickly to offers from potential volunteer states, to ensure that the program can be adapted, with minimum cost and delay, and to gain approval by the Congress. However, because there is no assurance that the Negotiator will be successful, the Department is considering proceeding with DOE-initiated MRS siting in coordination with the Negotiator efforts, subject to the constraints of the Nuclear Waste Policy Act.

2. PROGRAM ACCOMPLISHMENTS SINCE DECEMBER 1988

We will now provide a brief overview of program accomplishments since the last briefing by the Acting Director, OCRWM, to the Commission on December 20, 1988. On December 28, 1988 the Department of Energy published, and submitted to the Commission for review and comment, the Site Characterization Plan for the Yucca Mountain site, as required by the Nuclear Waste Policy Act, as amended. This plan provides the framework for the surface-based testing and underground investigations needed to assess the suitability of the site for a geologic repository.

In February, 1989, DOE submitted the ESF Title I Design Acceptability Analysis (DAA) to complement the Site Characterization Plan for Yucca Mountain. The DAA was prepared as part of a technical assessment review of the ESF, and in response to a suggestion made by the NRC staff in November 1988, that it would constitute an acceptable approach for demonstrating the acceptability of the ESF Title I design.

On July 31, 1989, the NRC published its Site Characterization Analysis (SCA). The SCA included two objections, 133 comments, and 62 questions. The two objections concerned (1) the Quality Assurance program, and (2) the design control process applicable to the ESF Title I design. DOE has an active program underway to resolve these concerns.

In the QA area, the OCRWM QA Requirements Document and QA Program Description Document and the Yucca Mountain Project QA

Requirements Document have been accepted by DOE and NRC. The Quality Assurance Program Plans of the contractors participating in the Yucca Mountain site characterization (F&S, H&N, REECO, SNL, LLNL, USGS, and LANL) have been accepted by DOE and NRC; the implementation of all of these plans with the exception of LANL has been audited by DOE and found acceptable. The NRC staff has witnessed these audits, has issued their evaluations for the audits conducted of F&S, H&N, SNL, and LLNL, and is evaluating their observations for the remainder. LANL will be scheduled for a re-audit in the near future. The qualification audits for the Yucca Mountain Project Office and OCRWM are currently scheduled for June and July, 1990, respectively. While the Department still has some work to do in this area as noted above, progress has been made toward a fully qualified QA program. New site characterization will not be initiated until the quality assurance for that activity is in place.

The DOE and NRC staffs have met several times during the last year to discuss the ESF design control process. The DOE has invited the NRC staff to observe the ESF Title II design process at several review points. We have found this kind of pre-licensing cooperative working relationship highly beneficial to both parties in the past, and encourage its continuation in the future.

In addition to the two objections, the SCA included a number of other comments. Many of them will be addressed in later reports, such as the Site Study Plans. Others will be addressed in the ESF Title II design. Some will be subjects for discussion in open technical interactions. In any case, the Department is considering each one of them in the course of its design and site characterization activities. As has been agreed to by the NRC and DOE staffs, the Site Study Plans are submitted to the NRC for review and comment. Eight study plans have been sent to the NRC and two have been accepted and completed the NRC's Start-Work Review, which indicates that the staff has no objection to DOE proceeding with those studies. A Detailed Technical Review by the NRC Staff is still in progress on these two study plans.

The Department has also received comments on the Site Characterization Plan from the State of Nevada. Although their comments were received substantially after the extended public comment period, the Department is reviewing, and is carefully considering, their comments. In general, the Nevada comments have been found to be similar to those of the NRC staff. The Department also has received comments on the SCP from the Edison Electric Institute (EEI), representing the nuclear utilities, as well as from other government agencies and from private citizens. All these comments are being carefully reviewed by the DOE staff.

The Nuclear Waste Policy Amendments Act created the Nuclear

Waste Technical Review Board (TRB), which consists of a Full Board and various panels covering specific technical areas. Since their establishment, the Department has made approximately 10 presentations to both the Board and its Panels. These have been in-depth technical presentations, sometimes lasting several days. The NRC staff has observed some of those meetings, and the Department suggests that they do so more frequently to augment their understanding of the DOE program.

The Technical Review Board has recommended more extensive underground exploratory drifting than had been planned for the initial period of site characterization. In addition, the Geotechnical Panel has recommended the use of tunnel boring machines for the construction of underground openings in the repository block, and the evaluation of alternate exploratory shaft construction techniques. The TRB also urged the Department to consider replacing one of the exploratory shafts with a ramp, and to raise-bore the other shaft in order to minimize disturbance of the repository block. The Department is presently evaluating all these recommendations, and has underway a more detailed study of the ESF alternatives. Since the Department's plans had been strongly influenced by the NRC's regulatory requirement for minimal disturbance of the repository block, these evaluations will consider excavation and testing with regard to satisfying information needs, regulatory concerns, and the waste isolation capabilities of the site. In addition to these TRB recommendations, the NRC staff, the Advisory Committee on Nuclear Waste, EEI, and the State of Nevada have suggested extensive surface-based exploration prior to underground excavations.

With respect to interactions between the NRC and DOE, there have been approximately 45 over the last year, including interactions with the Commission, ACNW, and the Staff, and covering several areas of interest to both agencies. The Department has worked with the NRC staff to establish three general types of interactions: technical meetings, technical exchanges, and site visits. During technical meetings the staffs discuss the respective positions of the two agencies and agreements may be reached and action items and/or commitments taken. Technical meetings were held during the past year on topics such as the ESF design control, quality assurance, and tectonics. Technical exchanges are the mechanism for openly discussing the views of our respective technical staffs to come to a better technical understanding of a particular subject matter, but no official positions are taken or agreements reached. Technical exchanges were held during the past year on topics such as substantially complete containment, waste container materials, a series of tectonics issues, and 10 CFR 60 flowdown to DOE requirements documents. Site visits provide a forum for the NRC staff to view first hand the characteristics of the site or a particular activity. Site visits were held during

the past year on topics such as volcanism, prototype core drilling, tectonics, and hydrology. We have found all these different types of interactions to be quite useful to the program. Furthermore, the State of Nevada and the units of local government have always been invited to attend and participate in all these interactions.

3. REGULATORY FRAMEWORK FOR REPOSITORY AND MRS

During this prelicensing period that has now extended to the year 2001 for the repository, the Department believes there is a unique opportunity and challenge for both the Commission and the Department, and for that matter, all the stakeholders in the program.

Stated simply, there is a need for a fresh look at the regulatory framework in the program. The fact that we both must face is that neither the Department nor the Commission has ever licensed a repository, or for that matter predicted the performance of a facility for 10,000 years into the future. We believe that if both our agencies are to be successful, the Department and the Commission must have a prelicensing relationship that represents the best that our respective agencies have to offer, namely, the Commission to guide us in understanding and interpreting the regulatory requirements and protecting the health and safety of the public, and the Department to implement, with Commission overview, the scientific investigations needed to give us all a proper understanding of the site and its suitability for isolation of the waste. This means, as noted earlier, a fresh look and an open and objective development of our prelicensing relationship. In this regard, the Department has several near and longer term suggestions, including an approach to joint development of regulatory criteria, where appropriate, during this prelicensing phase of the program. This approach to appropriate joint development of criteria is an initiative on collaborative interaction that we are proposing to the Commission for consideration. It will require an approach for this process that will assure there is no perceived compromise of NRC objectivity by the public. This will be discussed in more detail later (Section 3.3), but in summary it is an opportunity for experts from the NRC, DOE, industry, and others to come together to develop criteria that are reasonable and with which we will all be able to live in the future.

The following are some regulatory actions that the Department considers are needed:

3.1 NEED FOR NRC REGULATORY ACTION, SUPPORTED BY RULEMAKING

3.1.1 PETITION FOR RULEMAKING ON ACCIDENT-DOSE GUIDELINE

Unlike other NRC regulations, such as those pertaining to

power reactors or to independent spent fuel storage facilities, 10 CFR Part 60 lacks a so-called design-basis accident dose guideline. The DOE requires such a dose guideline to determine the need for, and the adequacy of, structures, systems, and components provided to prevent accidents or to mitigate their consequences. A description and analysis of these structures, systems, and components is to be included in the safety analysis report for the repository. The absence of the dose guideline creates uncertainty about how adequacy is to be established. The Department plans to petition the Commission to establish such a dose guideline by rule. The petition will propose that the accident-dose guideline be a 5-rem effective dose equivalent. This guideline would apply to any individual at the boundary of a newly defined "preclosure control area" at any time until the repository is permanently closed. The proposed guideline is generally consistent with the NRC accident dose guidelines for similar activities. Discussions have been held with the NRC staff and the proposal has been presented to the Advisory Committee on Nuclear Waste, generally with favorable reception. The petition will be sent to the Commission in the very near future.

3.1.2 EMERGENCY PLANNING

The Department understands that the NRC is planning a rulemaking on emergency planning criteria for the repository. These criteria will be needed for the design of the repository, and the Department agrees that the rulemaking process is the appropriate vehicle for this purpose. The Department recommends that the rule generally adopt the criteria contained in the final rule on emergency preparedness (54 FR 14051), published April 7, 1989, for certain fuel cycle facilities and other radioactive material licensees, licensed under Parts 30, 40, and 70, because the facilities licensed under those Parts are of the same general kind as the geologic repository. These types of facilities are not a nuclear-fueled power generating station and do not pose the same risk to the public, so that evacuation plans and drills are not required. It is suggested that conforming amendments be issued by rule for Part 60 as well as for Part 72.

3.1.3 IMPLEMENTATION OF THE EPA STANDARD

The EPA recently released a working draft of the proposed revised standard for the disposal of transuranic and high-level waste (40 CFR Part 191), and the NRC staff has recommended a process to the Commission which will result in an amendment that will conform Part 60 to the EPA standard. We agree that such an amendment is needed. However, the Department understands that the Commission is considering proceeding in parallel with the EPA schedule for promulgation of the EPA standard. This is of concern to the Department because it may result in two different standards that could lead to potential regulatory uncertainties.

3.2 TOPICS REQUIRING ADDITIONAL CONSIDERATION

The NRC's regulatory strategy paper, SECY-88-285, identified several topics that the Department agrees require regulatory action but which it believes are more appropriate for NRC regulatory guides or DOE topical reports rather than rulemakings, or that need to be considered further before deciding whether rulemaking is appropriate. The Department provided comments to the Commission in this regard in a letter (R. Stein, DOE to R. Browning) dated August 18, 1989. In 10 CFR 60 the NRC deliberately provided a regulation that is generally not prescriptive, recognizing that a repository has never been built and operated before. The Department agrees fully with that philosophy. This is not the time to reverse it. The Department believes it is prudent to retain the flexibility to propose alternative approaches to demonstrating compliance with the regulations, rather than being required to meet specific interpretations established by rule at this time in the exploratory stage of compliance. As indicated earlier, some of the uncertainties associated with demonstrating compliance with requirements that span several thousands of years into the future make it unrealistic to be able to close on certain issues until we have a better understanding of the site characteristics. The Department, therefore, suggests that further discussions be held on the need for rulemaking on these topics and that an alternative approach or approaches be evaluated.

3.2.1 AMPLIFICATION OF REGULATORY TERMS

In particular, the Department's concern here is with the NRC staff's plans to use rulemaking to provide further amplification of the following terms in the NRC regulations: "anticipated and unanticipated processes and events," "disturbed zone," "substantially complete containment," and "pre-waste-emplacement ground-water travel time." We believe that it is premature at this point in time to proceed to rulemaking on these topics. A better approach would be to let the definitions evolve as we move forward in our scientific investigations and learn more about the site. In view of the complexity of the concepts to which these terms pertain, any regulatory direction for their interpretation would require considerable discussion, especially to clarify in detail the various circumstances for the use of the subject material. Being a formal process for promulgating regulatory requirements, rulemaking is inappropriate for expounding nuances in the meanings of specific terms. The resultant rule may not provide the flexibility needed to address the variety of circumstances that may be encountered in the repository program.

In contrast, a DOE topical report, for example, or approaches developed under a process similar to that used to develop industry standards, and after having been reviewed and

accepted by the NRC, would contain the needed guidance, provide the needed flexibility, and require considerably less in the way of resources. While draft NRC staff technical positions have already been issued for three of these topics, the Department does not believe that such staff guidance or rules are appropriate in these cases. In addition, the Department has specific concerns on these draft positions and has submitted comments, some of which will be discussed below. If the NRC staff chooses to develop guidance in these areas, the Department prefers such guidance to be in the form of regulatory guides, because of the more rigorous internal review process.

3.2.2 METHOD FOR DEMONSTRATING COMPLIANCE WITH EPA STANDARDS

NRC's strategy paper indicates that NRC plans a rulemaking on the topic of demonstrating compliance with the EPA standards. The Department feels that this topic does not require a rulemaking because 10 CFR Part 60 will be revised to reflect the EPA standards. Furthermore, the Department feels that a DOE topical report or other guidance document would be a better vehicle for addressing specific methods for demonstrating compliance. A prescriptive methodology might be too restrictive and, at this point in the program, might limit alternative means of demonstrating compliance with the standard. The Department appreciates any guidance the staff might recommend, but also recommends that such guidance not be codified in the regulation. In addition, the Department suggests that certain regulatory requirements that may be overly restrictive and conservative when compared to the EPA standard, such as the subsystem performance objectives, be made regulatory guidance instead.

3.2.3 ENGINEERED BARRIER SYSTEM

The Department believes it would be particularly useful to allow credit for an improved engineered barrier system (EBS) in the regulatory analysis to show compliance with the EPA total system performance standard. Specifically, credit should be allowed for the waste package for a life greater than 1000 years. While it is understood that the present waste package performance requirements in 10 CFR Part 60 could be subject to varying interpretations, it appears that they preclude such a consideration. As stated earlier, it is premature to provide such prescriptive subsystem requirements until such time as we learn more about the capabilities of the entire waste isolation system, particularly the site.

3.2.4 CONTENT OF LICENSE APPLICATION

Part 60 outlines the information the NRC staff believes is needed to determine whether the construction authorization for a repository and the license to receive and possess radioactive waste should be granted. Obviously, the regulation does not

provide detailed annotation. Since the detailed regulatory guidance for the content of the license application is likely to be extensive, the Department recommends providing it in a regulatory guide rather than by rulemaking. The regulatory guide approach has been successfully used to provide guidance for the license applications of nuclear facilities, and we recommend the same approach for the repository. In fact, as you know, the NRC staff is presently developing such a regulatory guide for the repository.

3.2.5 GREATER-THAN-CLASS-C WASTE

The revision to 10 CFR Part 61 recognizes that, according to the Low-Level Radioactive Waste Policy Amendments Act of 1985, the Department has the statutory authority to select the method for the disposal of greater-than-Class-C (GTCC) low-level waste. Alternative disposal options are presently being evaluated. Development of the criteria for disposal is one of the regulatory activities on which DOE, NRC, and others could work more closely together to formulate future regulatory guidance. For example, prior to the NRC proposing rulemaking on the criteria for GTCC waste disposal, a group of waste disposal experts from the Federal government, industry, and State could be put together to prepare draft guidance that would serve to support a potential rulemaking in the future, if it were determined that it was needed. This guidance, and eventually the regulation, would include criteria for the containment of the waste in a facility, including suggested methods of packaging for emplacement in a disposal facility, of handling releases from the package, and for stabilization.

3.2.6 OTHER AREAS OF CONCERN

There are several other areas of concern the Department would like to address. First, the technical ones.

3.2.6.1 Definition of Anticipated Processes and Events

Part 60 defines anticipated processes and events as "those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved." As already mentioned, the NRC staff's interpretation of this definition is included in a draft technical position and is planned to become part of a proposed rulemaking action. The Department strongly disagrees with the staff's interpretation of the regulation, which would require the DOE to consider any Quaternary event--that is, any event that has occurred in the past 1.8 million years--as being anticipated. Considering the span of the waste isolation period, which is on the order of 10,000 years, the Department finds this interpretation unreasonable. Here again, the DOE, NRC, and others might work together to formulate future regulatory guidance.

3.2.6.2 Application to repository of criteria from 10 CFR 100 Appendix A

The NRC staff has proposed, in a draft technical position, the use of 10 CFR 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," for the geologic repository. In the Department's opinion, the criteria may be useful in screening reactor sites, but they are inappropriate for a repository. The response of a complex above-ground rigid structure, like a reactor building, to the energy from a seismic event is completely different from the response expected from a deep underground facility, and the safety risks are quite different. Nor is it appropriate for the surface fuel handling facilities of the repository, when one considers the relative risks associated with a reactor as compared to a repository. Moreover, the methodology in Appendix A is not considered to be present state-of-the-art. The seismic design of the repository should be addressed in a continuing dialogue between the NRC and DOE staffs, industry, and State.

3.2.6.3 Schedule for the Licensing Support System

The LSS Administrator has proposed actions supporting the early development of the LSS. The Department generally agrees with overall approach, such as the development of a prototypical LSS, and the identification of priorities for document categories to input in the system. The Department, consistent with budget limitations, will work closely with the LSS Administrator to have the LSS developed at the earliest possible time to ensure the system will be ready to support the repository licensing process when it is needed. As indicated in the Supplementary Information accompanying the final negotiated rule on LSS (10 CFR Part 2, Subpart J), issued on April 14, 1989, a Memorandum of Understanding (MOU) between the NRC and DOE to delineate responsibilities for system development and operation and to specifically identify the relationship between the LSS Administrator and the DOE needs to be prepared as a first priority. This MOU should also establish the general process by which document backlog will be controlled prior to system availability. Presently, OCRWM has in place a records management system to capture the records developed in this program. A subset of these records will eventually be input to the LSS. To the extent practicable, we have assured that the computerized index is compatible with the expected LSS indexing scheme.

3.2.6.4 Resources Available to the Advisory Committee on Nuclear Waste

The constructive criticism of the Advisory Committee on Nuclear Waste has been helpful and beneficial to the program, and their comments have been appreciated. The Department is concerned, however, that the Committee does not have the

resources to review, usually on short notice, the extensive reports generated in our program, such as the eight-volume Site Characterization Plan, the very detailed Study Plans, and the future topical reports. During the recent SCP and SCA reviews, the members and the expert consultants available to the Committee depended primarily on NRC staff briefings, a practice which limits their ability to receive separate and independent detailed briefings of the DOE work by the DOE staff and its contractors. We believe that because of the competence and regulatory perspective of the ACNW, these interactions can be beneficial to both the NRC and the DOE in providing a more comprehensive perspective of the issues.

3.3 INITIATIVE ON COLLABORATIVE INTERACTION

As indicated earlier, the Department believes that we both have a unique opportunity here to take a fresh look at the regulatory framework for this program, and have suggested that our staffs continue to work closely together to reach a better understanding of such framework. As we all know, the technical challenges that this program has to offer are not simple ones. However, we believe that the program as a whole has the requisite expertise to overcome these hurdles. Rather than proceeding down separate paths and potentially diverging, we think that it is time to start using our collective resources more effectively to work towards a common end goal. Consequently, the Department proposes an initiative for collaborative interaction that would not only involve our two staffs, but would also bring in the expertise from other Federal agencies, the nuclear industry, the Nuclear Waste Technical Review Board, the ACNW, the State of Nevada, and others. For example, a group of waste disposal experts from these organizations could come together to prepare a draft document, similar to the approach used for the development of a technical standard by a national standards committee (e.g., ANSI, ANS, ASME, etc.). This is an approach that has been used effectively throughout the nuclear industry and has been quite successful in European countries. This joint effort would include the development of technical and regulatory criteria as well as interpretation of regulations.

We firmly believe that such a process will allow all of us to take full advantage of the prelicensing consultation period and that it will contribute significantly to developing a better understanding amongst all parties of the technical/regulatory issues with which we will all have to deal during the licensing process.

4. CONCLUSION

The Department of Energy asks the Commission's continued cooperation and support as the site characterization and other elements of the repository program outlined by the Secretary are

implemented. The Department specifically solicits the Commission's help in resolving the issues raised here and requests that careful consideration be given to our initiative on collaborative interaction. The Department also asks for the Commission's support for MRS and transportation strategies that are designed to satisfy the increasing need for timely spent fuel storage.

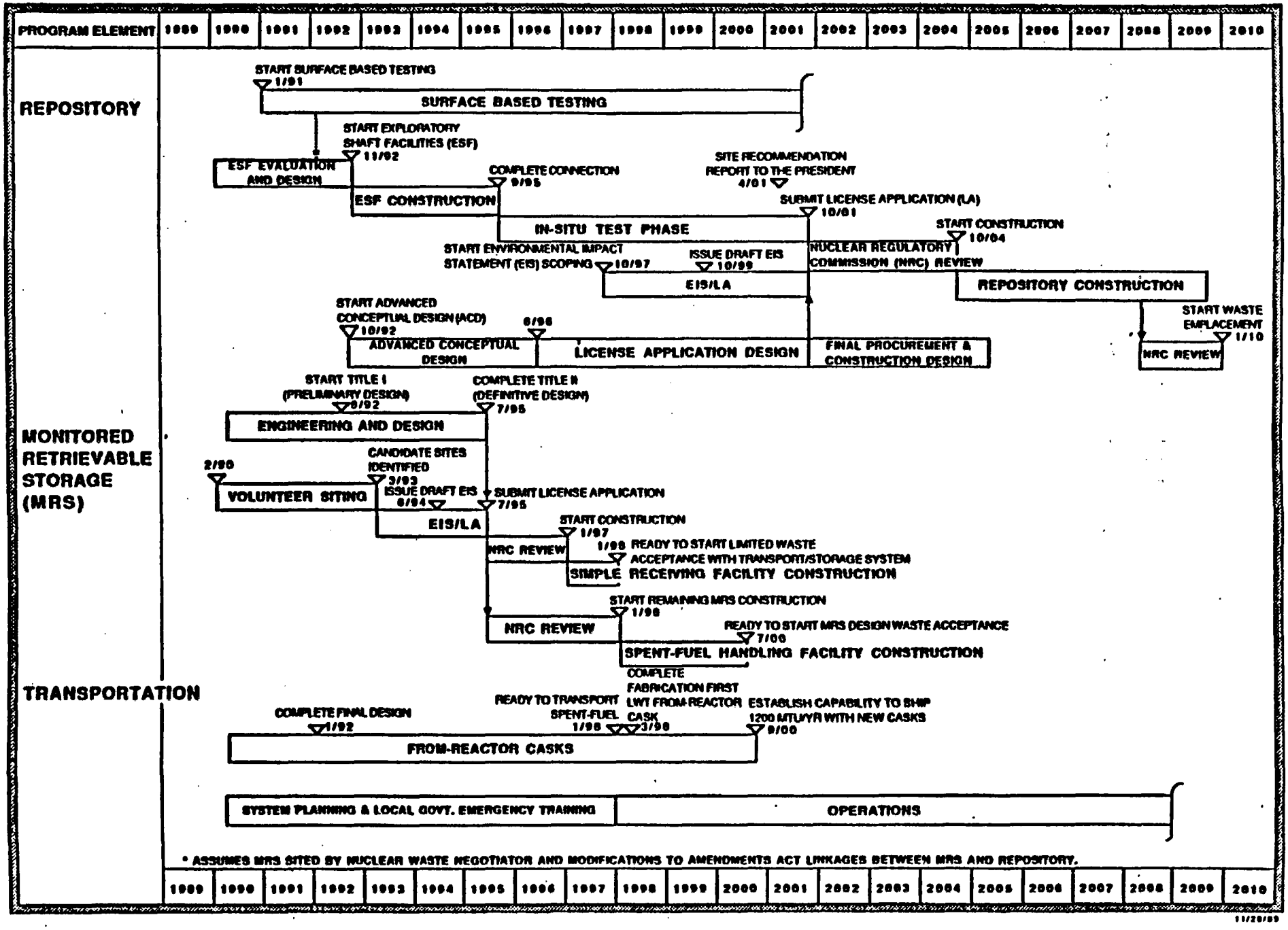

FIGURE 1. REFERENCE SCHEDULE FOR RESTRUCTURED PROGRAM *

ENCLOSURE 4 A, B

PROCEEDINGS OF THE
1989 JOINT INTERNATIONAL
WASTE MANAGEMENT CONFERENCE

VOLUME 2

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edited by

S. C. Slate
R. Kohout
A. Suzuki

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ENCLOSURE 5

THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S RADIOACTIVE WASTE DISPOSAL REGULATORY ACTIVITIES

F. L. Galpin, W. F. Holcomb, J. M. Gruhlke, and D. J. Egan, Jr.
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C.

ABSTRACT

The U.S. Environmental Protection Agency has issued and is developing generally applicable environmental standards for the disposal of various types of radioactive wastes. Standards have been issued for the disposal of spent nuclear fuel, high-level and transuranic wastes, and for uranium mill tailings. Standards have been proposed for the land disposal of low-level radioactive waste and for disposal of discrete, non-diffuse, low-volume, high-concentration, Naturally Occurring and Accelerator-Produced Radioactive Materials wastes. Regulations for ocean disposal of low-level radioactive wastes are also under consideration.

INTRODUCTION

The United States Environmental Protection Agency (EPA) has the responsibility and authority to develop standards and guides to minimize adverse impacts on public health and the environment from radiation. A major part of this effort over the past few years has been directed at radioactive waste disposal activities.

There are several reasons why EPA does not have just one radiation exposure standard to cover all waste activities. First, several laws provide EPA with radiation protection authority. The criteria to be met by these different laws vary considerably, making it most unlikely that the same standard could meet all of them. The second reason for differences is the feasibility of implementation for the particular situation. A cost-effectiveness analysis is also usually done as part of the basis for the standards.

ENVIRONMENTAL STANDARDS FOR URANIUM AND THORIUM MILL TAILINGS

The EPA's standards for inactive and licensed uranium mill tailings sites have as their two primary objectives for control of hazards from tailings, isolation and stabilization to prevent misuse by man and dispersal by natural forces (floods, wind, rain, etc.) and stabilization of the piles to control radon emissions and prevent seepage of hazardous constituents into ground water. The standards for inactive sites (EPA 1983a), require that, for disposal of tailings, control measures shall be designed to: (a) be effective for up to one thousand years, if reasonably achievable, and, in any case, for at least two hundred years; and (b) provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not exceed an average release rate of 0.74 $Bq/m^2/sec$ or alternatively, will not increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than 0.01 Bq/L. The inactive site standards also require cleanup to limit soil contamination and assure that in any occupied or habitable building a reasonable effort shall be made to achieve the annual average radon decay product concentration (including background) not to exceed 0.02 WL (Working Level, i.e., exposure to radon decay products). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL and the level of gamma radiation shall not exceed the background level by more than 5.2 nC/kg/hr.

The standards for licensed sites (EPA 1983c) include both operational and closure phases. Operational phase standards require that: (a)surface impoundments must have a liner, unless exempted by the regulating agency; (b) a monitoring system be operated; (c) a corrective action program be conducted, if the ground-water protection standards are being exceeded; (d) the exposure limits of 0.25 mSv/yr, are met (EPA, 1977b); (e) standards, under the Clean Water Act, are met i.e., prohibiting discharges to surface waters, except at locations where annual average precipitation exceeds average annual evaporation (EPA, 1982); and (f) standards, under the Clean Air Act, for radon-222 emissions from tailings are met (EPA, 1986). Closure standards are the same as for the inactive sites.

Court Actions

The uranium mill tailings standards were contested by the uranium industry, environmental groups, States, and by individuals. The Court dismissed all challenges except asking that quantitative ground-water standards for inactive tailings be required. The Agency has proposed quantitative ground-water concentration standards for inactive sites to replace those qualitative provisions set aside by the Court (EPA, 1987).

ENVIRONMENTAL STANDARDS FOR THE MANAGEMENT AND DISPOSAL OF SPENT NUCLEAR FUEL, HIGH-LEVEL AND TRANSURANIC RADIOACTIVE WASTES

The EPA's standards for spent nuclear fuel, high-level (HLW) and transuranic (TRU) radioactive wastes, apply to management and storage operations and set release limits for disposal systems (EPA 1985).

Subpart A establishes radiation dose limits of 0.25 mSv/yr to members of the public resulting from the management and storage of spent fuel, HLW or TRU radioactive wastes (except for transportation) at facilities licensed by the NRC, and facilities managed by the DOE at waste disposal facility sites.

The Subpart B, disposal portion had containment (quantitative), assurance (qualitative), individual protection, and ground-water protection requirements. The containment requirements set numerical limits on the projected release of specific radionuclides as a function of release probability to the accessible environment over the 10,000-year period following closure of the repository. The limits are based on an overall societal objective of no more than 1,000 excess cancer deaths over 10,000 years from 100,000 metric tons of spent fuel.

The individual protection requirements limit the exposure from the disposal system to a member of the public in the accessible environment to 0.25 mSv/yr, for the first 1,000 years after disposal. The ground-water protection requirements apply only to ground-water supplies serving thousands of people, and for 1000 years limit the water withdrawn from these special sources to concentrations as set forth in EPA's National Primary Drinking Water Regulations (EPA 1976).

The assurance requirements are principles to provide an extra margin of assurance that the containment requirements will be met despite the large uncertainties that confront the prediction of disposal-system performance over 10,000 years. The essence of the six assurance requirements is: (a) disposal systems shall not depend on active institutional controls for more than 100 years after the closure; (b) long-term disposal system performance should be monitored for a reasonable time; (c) disposal systems shall be marked and their locations recorded in appropriate government records; (d) disposal systems shall be designed with several different types of barriers; (e) sites should not be located where scarce or easily accessible resources are located; and (f) wastes shall be recoverable for a reasonable time after disposal.

Legal Action Concerning 40 CFR Part 191

In 1986, several environmental groups and states, filed petitions for review of these standards. The Court remanded Subpart B so that: (a) EPA must reconcile the Sections on individual and ground water protection requirements with the Safe Drinking Water Act's (SDWA) Part C requirements on underground injection or adequately explain the divergence; (b) EPA must supply an adequate explanation for selecting the 1,000-year design criterion in the two Sections and (c) the Ground-Water Protection Requirements Section was promulgated without proper notice and comment and must be reproposed for public comment.

ENVIRONMENTAL STANDARDS FOR THE MANAGEMENT AND LAND DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES AND NARM WASTES

The Agency has proposed generally applicable environmental standards for the land disposal of all low-level radioactive waste (LLW) materials not controlled by other EPA standards at all Federal and commercial LLW disposal facilities and standards for disposal of Naturally Occurring and Accelerator-produced (NARM) wastes (EPA, 1989).

LLW Rationale

The EPA LLW standard has several elements. The pre-disposal part of the standard will limit annual effective whole body exposures from all environmental pathways to any member of the public from regulated LLW disposal facilities; and "away-from-generator" LLW management and storage facilities. These limits would make the EPA LLW Standard parallel and consistent in structure with the 0.25 mSv/yr standards EPA has promulgated for the Uranium Fuel Cycle standards (EPA, 1977b).

The post-disposal part of the Standard will establish limits on exposure through all pathways to members of the public from the land disposal of LLW. It would apply to any LLW disposal facility using any land disposal method any place in the United States. EPA's technical analysis has not revealed any reason to significantly depart from a 0.25 mSv/yr level.

Two sets of groundwater protection requirements are being considered for public comments. In both cases, Class I ground waters, those that serve as irreplaceable sources of drinking water for large populations, will require non-degradation criteria. The two proposals would differ with respect to the protection levels for Class II ground waters. One option is to protect all Class II ground waters to the National Primary Drinking Water Regulations (EPA, 1976) which would have a recommended limit of 0.04 mSv/yr. The other option would divide the Class II ground waters into high-yield (suitable for a community supply) and low-yield aquifers. The high-yield sources would be protected to the 0.04 mSv/yr level while the low-yield sources would be included in the basic 0.25 mSv/yr. In both proposals, all Class III ground waters would be included in the basic protected to 0.25 mSv/yr standard.

The qualitative implementation requirements would compensate for the uncertainties that necessarily accompany plans to isolate radioactive wastes from the environment for a long time. They include considerations concerning: active institutional controls (such as guarding and maintenance); passive institutional measures (such as permanent markers); monitoring during disposal and post-disposal phases; and location away from areas containing materials not widely available from other sources.

Criteria for identifying wastes with sufficiently low levels of radioactivity to qualify as "Below Regulatory Concern" (BRC) are proposed. Any waste meeting these criteria could be disposed of as a non-radioactive waste. However, if it had hazardous non-radioactive characteristics, it would have to be disposed of in compliance with EPA's hazardous wastes regulations.

Our economic analyses show that the use of a BRC criteria to eliminate certain low-activity radioactive wastes from full LLW regulation and disposal process is very cost effective. EPA estimates that approximately 35% by volume of all LLW could be re-classified as BRC with a resulting maximum annual dose to an individual of less than 0.04 mSv/yr and potential savings of more than 600 million dollars over 20 years.

NARM Coverage

The considerations for the regulation of NARM are to:

(a) Assure the same disposal of discrete high activity NARM wastes in regulated sites; and

(b) Provide for a manifest system that will track the NARM waste from generator to disposal.

An important point on the NARM coverage of an EPA standard is specifically which NARM wastes are to be covered. We presently are excluding those high volume diffuse wastes such as mine over-burden and benefication residuals. That is not to say that these latter waste are not deserving of some type of regulation, just that they are not appropriate for coverage under these LLW Standards.

NARM waste proposed for regulation includes any NARM waste whose radioactivity concentration exceeds 74 Bq/gm, but exempts certain consumer items.

OCEAN DISPOSAL REGULATIONS AND CRITERIA

The Agency's ocean dumping regulations (EPA, 1977a) specify that high-level radioactive wastes and radiological warfare agents are prohibited from ocean disposal, and that other radioactive materials must be contained to prevent direct dispersion or dilution in ocean waters.

Congressional amendments (Congress, 1983) required that: (a) for a 2-year period after enactment, EPA could issue only research permits relative to LLW disposal; (b) after the 2-year restriction, all applicants must prepare and submit to EPA a site-specific Radioactive Material Disposal Impact Assessment; and (c) if EPA determines that a permit should be issued to the applicant, the recommendation must be transmitted to both Houses of Congress and approved by a joint resolution. No permits have been issued to date.

The EPA participates in many of the International Atomic Energy Agency's (IAEA) programs and is also closely following the activities of the London Dumping Convention (LDC).

Presently, EPA is revising the 1977 regulations to: (a) include consideration of availability, capacity and impacts of land-based alternatives; (b) incorporate statutory amendments made subsequent to the 1977 regulations; (c) include the quantitative defintion of high-level radioactive waste developed for the LDC (IAEA, 1978, 1986), and (d) revise existing criteria in view of continued field experience and refinement of testing procedures and site designation protocols.

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ENCLOSURE 6

Field Tour Guide

for

ono Mine Gallery (Tsukiyoshi Deposit)

and

homasama Hydrological Test Site

Chubu Works

Power Reactor and Nuclear Fuel

Development Corporation (PNC)

JAPAN

Welcome

Please note presentation and transportation arrangements have been made on your behalf for the duration of your visit at Chubu Works, JAPAN.

Schedule for Field Tour

October 26, 1989;

13:00 p.m.	Arrival at Chubu Works, PNC
13:05-13:20 p.m.	Brief Overview of Recent Research and Development Activities on Geological Disposal Programme for HLW at Chubu Works.
	Introduction of Field Tour.
	《 Change Cloths 》
13:25 p.m.	Depart for Shomasama Hydrological Test Site
	《 Bus Transportation 》
13:40 p.m.	Arrival at Shomasama Hydrological Test Site
13:40-14:25 p.m.	Shomasama Hydrological Test Site
14:25 p.m.	Depart for Tono mine
14:40 p.m.	Arrival at Tono mine
14:45-15:45 p.m.	Tour on Tono Mine
15:50 p.m.	Depart for Chubu Works
16:05 p.m.	Arrival at Chubu Works
16:05-16:20 p.m.	Visit at Experimental Laboratory
	《 Change Cloths 》
16:25-16:40 p.m.	Technical comments on PNC activities
16:45 p.m.	Depart for Kyoto

Field Tour

(Expositor)

Meeting Room ;

- Brief Overview of R&D Activities of PNC at Chubu Works
- Introduction of Field Tour
  (H. Yamakawa)

Tono mine gallery ; (see next two pages)

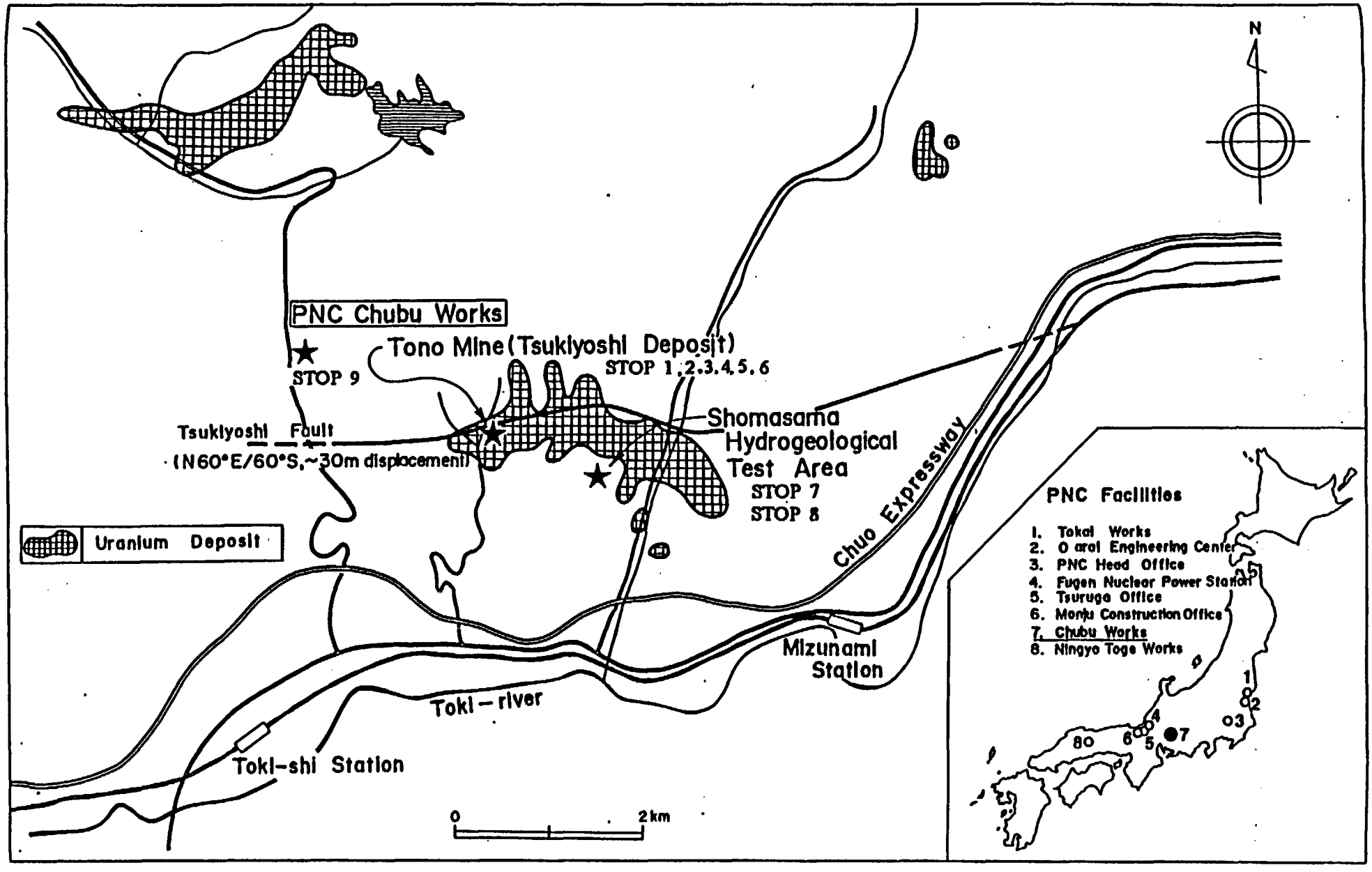
– STOP 1 (Y. Yusa)	Engineered Barrier Materials Field Tests
– STOP 2 (Y. Ochiai)	General programme and work scope on Natural Analogue Studies
– STOP 3 (T. Seo)	Hydrogeochemistry of groundwater
– STOP 4 (S. Takeda)	Geochemistry of Natural U-Th Series Nuclides Uranium Mineralization
– STOP 5 (K. Sugihara)	Mine-by Experiments on Excavation Responses
– STOP 6 (Y. Ninomiya)	Shaft Excavation Effect

Shomasama Hydrological Test Site ;

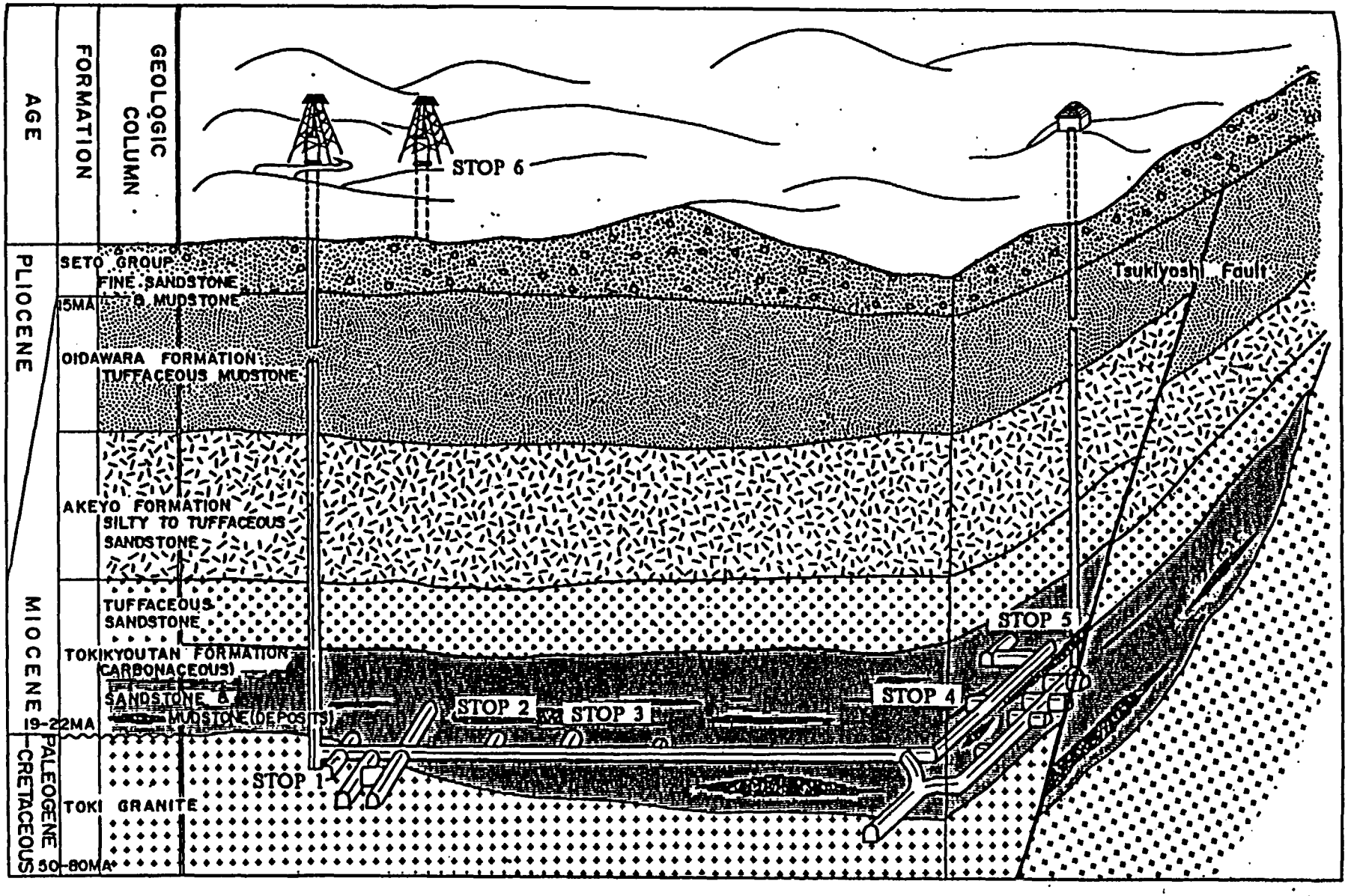
– STOP 7 (K. Yanagizawa)	Hydrogeological Investigation for Regional Groundwater Flow.
– STOP 8	New Tools for site Investigations of Deep Geological Environment
(K. Yanagizawa)	(A) Hydrological Equipments
(K. Noritake)	(B) Geophysical Equipments

Experimental Laboratories at Chubu Works

– STOP 9 (K. Nakano)	Experimental Laboratory Hydraulic Conductivity Measurement System



Location Map of Test Area in Tono Mine and Adjacent Area



Location of "STOP" on Excursion Trip in Tono (Tsukiyoshi Deposit) Mine Gallery.

STOP 1 ; Engineered Barrier Materials Field Tests

Objectives

(1) Evaluation of chemical durability of waste glass under field conditions.

(2) Evaluation corrosion behavior of overpack materials under field conditions.

(3) Establishment of experimental methods of field tests for engineered barrier materials.

Test items

(1) Hydrological characterization of field test site:

- Sampling and analysis of groundwater composition.
- Periodic monitoring of groundwater;

  pH, Eh, DO, conductvity and temperature measurement.
- Groundwater flow measurement.

(2) Engineered barrier materials corrosion tests under field conditions:

- Leaching test of simulated waste glass;
  (Glass=P0798, Temperature=19℃, 90℃)
- Corrosion tests of candidate overpack materials;
  (Specimen: mild steel, cast steel, copper, titanium alloy(ASTM G-12Ti), hastelloy C, Temperature:19℃)
- Evaluation of specimens;

  Corrosion rate(weight loss), analysis of alteration layer and corrosion products(SEM, XRD)

Result

(1) Hydrological charaterization of field test site:

- Tono groundwater chemistry (See Table 1);
  $Na\text{-}HCO_3$ Type
- Hydraulic conductivity at Tono test site;
  10^{-4}~10^{-5}cm/sec

(2) Corrosion behavior of engineered barrier materials under field condititions:

- Waste grass (P0798) leach rate as a function of temperature (See Fig.2);
  The activation energy (65KJ) of waste glass alteration caluculated from field leaching tests was quite similar as that obtained from a soxhlet test in laboratory.
- Overpack materials weight loss as a function of time (See Fig.2);
  Weight loss of test specimens (mild steel, cast steel and pure copper) in field tests at Tono test site were smaller than those in laboratory tests using Tono groundwater.
  Very low corrosion rate at the field tests was obtained for Titanium, its alloy and nickel alloy.

STEP 2; General Programme and Work Scope on Natural Analogue Studies

Objectives

(1) Contribution to validation of migration models in natural barrier for long-term safety assessment.

—To understand geochemical basis related to migration and fixation of U-series nuclides for long-term prediction models.

(2) Contribution to the site investigation process.

—To develop the methodology and equipments for the characterization of suitable geological environment for isolation of radioactive wastes.

(3) Contribution to establishment of public acceptance.

—To support the feasibility of geological isolation of radioactive wastes in Japanese geological environment.

Work Scope

The following studies are in progress to investigate fixation-migration of U-series nuclides, and its relevant geological and geochemical environment.

(1) Migration and retardation studies uranium of series nuclides.

—Uranium series disequilibria in ore zone and around the Tsukiyosi Fault.
—In-situ distribution coefficients
—Matrix diffusion into granite boulders in ore zone.
—Transportation to biosphere.

(2) Geochemical study of groundwater.

—Geochemical parameters.
—Characterization of natural colloids.
—Geochemical modelling of groundwater.

(3) Hydrogeological study at Tono area.

—Hydrogeological parameters.
—Modelling of groundwater flow system.

(4) Geological and geochronological study.

—Occurrence of uranium deposits.
—Geological history of Tono area.
—Mineralogy of host rock.

(5) Migration modelling.

—Data base of above studies.
—Validation of models.

Remarks

(1) General and economic geology have been studied i.e. stratigraphy, geological structure, geological history, ore distribution, ore grade ore charcteristic, mineralogy of host rock, etc.

(2) There is no evidence of migration of uranium series nucides such as ^{238}U, ^{234}U and ^{230}Th for a period of at least 1 million years.

(3) ^{226}Ra has been migrated over a distance of several meters for recent thousand years.

(4) The chemical and isotopic composition is charcterized in correspondence with the stratigraphy.

(5) The tritium concentration in groundwater show that shallow groundwater is directry recharged by rainfall and discharge very quickly and the deep groundwater is stagnant.

STOP 3; Hydrogeochemistry of groundwater

Objectives

(1) To investigate the chemical condition of groundwater collected in representative formations from the Tsukiyoshi ore body.

(2) To investigate the interaction of groundwater and host rock and their influence on radionuclide transport.

(3) To investigate the characteristics and chemical composition of natural colloids in groundwater.

Works

The following works are undergoing;

(1) Measurement of the concentration of cation and anion in groundwater.

(2) Measurment of the physicochemical parameters for groundwater such as pH, Eh, DO and COND.

(3) Measurement of the isotopic composition of groundwater such as $\delta^{18}O$, δD and ^{3}H.

Results

(1) In correspondence with the stratigraphy, there are significant difference in the geochemical characteristics.

(2) The groundwater of ore zone is characterized that it contains bicarbonate, sodium and fluoride higher than surface or shallow groundwater.

(3) Isotopic data of $\delta^{18}O$ and δD of groundwater have been obtained. The data show a distinct difference between the above two type water.

STOP 4; Geochemistry of Natural U-Th seies Nuclides (Disequilibrium of Uranium series Nuclides)

Objectives

(1) To estimate the time scale and spacial sacle of migration of U-series nuclides in sedimentary ore zone and fault zone.
(2) To identify the minerals on which U-series nuclides are fixed.
(3) To understand the geochemical mechanism related to migration and fixation of U-series nucides for long-term prediction model.

Works

The measurement of U-series disequilibrium and analysis of associated minerals are in progress concerninig the following samples.

(1) Three dimensional grid samples in fresh ore zone of gallery.
(2) Two dimensional grid samples in fault zone of gallery.
(3) Drilled core samples in ore body along the direction of groundwater flow.
(4) Drilled core samples in the vicinity of fault zone.

Results

(1) Uranium has not been migrated over distances of 1 m for at least recent 1 million years.
(2) ^{226}Ra has been leached over distances of 1 m for recent thousands years.
(3) Radioactive disequilibrium is observed within a few meters along fault zone.
(4) Uranium is associated with various materials such as zeolite, clay titanium compound and organic carbon.

STOP 5 ; Mine-by Experiments on Excavation Responses

Objectives

(1) Preliminary study on the monitoring system of excavation responses.

(2) Test and evaluation of the instruments and methods which are currently available for the measurements of rock mass behavior.

(3) Aquisition of the geomechanical and hydraulic data on excavation responses for the preparation of the further experiments in the actual deep underground research laboratory.

Works

(1) Pilot boring for the initial investigations.

(2) Laboratory tests on the boring cores.

(3) Geological mapping.

(4) Measurements of the pourwater pressures.

(5) Permeability measurements.

(6) Measurements of the rock mass displacements.

(7) Measurements of the axial stress of rockbolts.

(8) Borehole loading tests.

(9) Seismic tomography.

(10) In-situ stress measurements

(11) Groundwater level monitoring.

(12) Comparison of the actual rock mass displacements with the predicted ones by the F.E.M.model.

Results

(1) Rock mass displacement was almost terminated when the excavation face procceeded about 2times of the drift diameter from the measuring point.

(2) In-situ stress was not isotropic.

(3) Permeability measurement was impossible at the zone of 0.5-1.0m from the drift face after the drift excavation.

(4) Seismic survey suggested the low velocity zone of 0.8m thickness around the drift.

(5) F.E.M. simulation result was consistent with the actual measurements assuming the excavation influeuced zone of 1.0m thickness around the drift.

STOP 6; Shaft Excavation Effect Project

Objectives

(1) Evaluate the mechanical and hydrological characteristics of the rock mass which is influenced by the shaft excavation.
(2) Evaluate the change of hydrological condition around the shaft.
(3) Develop the repository design and the performance accessment of geological isolation for nuclide transport.

Works

(1) Measurement of the mechanical and hydrological changes of the zone influenced by the shaft excavation.
(2) Numerical model development of the groundwater flow around the shaft.
(3) Natural analogue study.

Remarks

Following items are being prepared as the pre-excavation monitoring ;
(1) Tensiometers and piezometers for the monitoring of the subsurface water flow are installed.
(2) Boreholes of up to 200m depth are being drilled and geophysical loggings, BTV-monitoring and permeability measurement are being performed.
(3) MP systems are being installed and the multiple piezometric pressure measurements are performed in some boreholes.
Shaft excavation is planned to start early next year.

STOP 7; Hydrogeological Investigation for Regional Groundwater Flow

Objectives

(1) Development of methodology and equipment for analyzing the groundwater flow relevant to mechanism of radionuclide migration.

— To develop method of hydrological, hydrogeological and hydrogeochemical investigation.

— To develop equipments obtaining data relevant to hydrological, hydrogeological and hydrogeochemical characters.

(2) Development and validation of groundwater flow models for long-term safety assessment.

— To understand hydraulic and hydrogeological characters related to the 3D-migration model in the regional area (12km×15km×depth 1,000m) including Tsukiyoshi Uranium deposites.

— To develop regional three-dimensional hydrological models.

— To validate reional three-dimensional hydrological models by hydraulic data obtained on hill-slope (surface and subsuface) hydrology and in borehole and drift.

(3) Contribution to estabishment of public acceptance.

— To support the feasibility of hydrogeological isolation of radioactive waste in the Japanese rainy environment.

Works

The following studies are in progress to investigate hill-slope hydrology, hydrogeological characters. And it is also to develop the hydraulic equipment and to establish the model.

(1) Investigation of hill-slope hydrology.

— Lineament analysis by LANDSAT.

— Vegetational and morphological analysis by aerial photpgraph.

— Geological and topographic interpretation by mapping.

— Zebra map and drainage interpretation by topographic map.

— Hydrogeological interpretation by ground surface mapping.

— Investigation of surface hydraulic characterization of evapotranspiration, river flow and precipitation.

— Measurement of specific discaharge and electric conductivity.

(2) Hydrogeological characters.

2-1 Core logging

— Investigation of fracture characterization(fracture pattern,filling materials,RQD etc.)

— Measurement of physical properties(effective porosity, density and hydraulic conductivity etc.)

2-2 borehole hydraulic investigation

— Measurement of hydraulic parameters(hydraulic conductivity, pore pressure and groundwater flow velocity by tracer test).

— Geophysical logs(sonic log, neutron log, BHTV and RADER etc.).

— Measurement of groundwater physico-chemical parameters(Eh, pH, electric conductivity and groundwater composition etc.) and groundwater sampling.

2-3 Hydraulic investigation in drift

— Geological analysis of fracture system.

— Measurement of hydraulic parameters(hydraulic conductivity,pore pressure and groundwater discharge etc.).

— Evaporation analysis on tunnel wall.

— Geochemical analysis of groundwater composition and filling materials in fracture.

(3) Development and validation of 3D regional hydrogeological models.
(TAGSAC CORD developed by Dr. WATANABE, SAITAMA UNIVERCITY)

— Data base of above studies.

— Validation of regional three-dimensional hydrogeological model from hydraulic data obtaining on hill-slope hydrology, and in borehole and drift.

— PNC Tracer Test System.

— PNC Gechemical Logging System.

(4) Development of hydraulic equipments.

— PNC Aquifer Test System.

— PNC Low Pressure Lugeon Test System.

— Hydraulic Testing Machine(Laboratory Permeability Test).

— PNC BAT Groundwater Sampling System.

— PNC Tracer Test System.

— PNC Geochemical Logging System.

Results

(1) Based on core observation, most of the fractures are classified as four types as follows. ①Planer type, ②Irregular type, ③Curved type, ④Stepped type(Fig.1).

(2) In-Situ hydrulic conductivity in the granite is approximately 10^{-4}~10^{-5} cm/s at fracture-predominants parts, 10^{-7}~10^{-8}cm/s at fracture-predominant parts in case of occurence of filling-minerals in fracture, and 10^{-8}~10^{-9}cm/s at fracture-poor parts measured by PNC Aquifer Test Method(Fig.2).

(3) In-situ hydraulic conductivity at fracture-predominant parts in the granite tends to descrease with depth as areas in some other countries (Fig.3).

(4) Hydrogeological models has been developed for groundwater flow in the sedimentary rock and the granite, considering the recharge of water from the overlying high permeability Seto Group, the geochemical analysis of the surface-water and the groundwater, the geological survey, and the in-situ hydraulic test(Fig.4).

STOP 8; New Tools for Site Investigations of Deep Geological Environment

(A) Hydrological Equipments

Objectives

—To characterize hydraulic and geochemical characteristics of deep geological environment.

These following equipments are developed.

(1) PNC Aquifer Test System

—Equipment can measure hydraulic conductivity and pore pressure in low permeability rock (from 10^{-9} to 10^{-4}cm/sec hydraulic conductivity).

(2) PNC Geochemical Logging System

—Groundwater sampling equipment which can continuous sampling from deep borehole.

—This equipment can simultaneously measure pH, Eh, EC and temperature during groundwater sampling.

(3) PNC-BAT Groundwater Smpling System

—Groundwater sampling equipment under the condition of non-gas and pressured.

(4) Evaporation measurement system

(Developed by Dr. WATANABE, Saitama Univ.)

—The rate of evaporation flow in low permeability rock on a tunnel wall.

(B) Geophysical equipments

Objectives

Development of efficient geophysical instruments for reconnaissance investigation of deep geological environment.

(1) 4 Channel Carbone (Fig.1,Fig.2)

The 4 channel carborne system has been developed to establish

(a) the radioactive method due to radon gas and its daughters for detecting active faults and

(b) the principle of 4 channel carbone method for reconnaissance investigations on deep geological environment.

Current works include

(a) an application to know active faults and

(b) improvement of the system.

(2) PLMT Method (Fig.3,Fig.4)

The Power Line Magneto-Telluric method was developed to establish a new tool for reconnaissance resisitivity mapping of deep geological enviornment and is being applied to resistivity mapping of different geological environment.

(3) Borehole Radar System (Fig.5,Fig.6)

Ramac system, which was developed by STRIPA project, will be used for detail fracture mapping at depth up to 1000m in different rock types in Japan.

STOP 9; Hydraulic conductivity Measurement System

(Hydraulic Testing Apparatus)

Objectives

Measurement equipment hydraulic conductivity of low permeability rock at high temperature and high pressure conditions.

Works (Fig.1, table1.)

An extensive effort has been paid to develop a hydraulic conductivity measurement equipment for the low permeability rock in labolatory.

The development was emphasized to minimize the temperature dependance of the pressure within the system.

The developed system has a capability to apply both constant pressure method and transient pulse method suggested by Brace et al. covering the range 10^{-6} to 10^{-12}cm/ sec.

We intend to establish standard measurement specification which has not been established for the very low permeability.

Remarks

The system has began its regular measurement and is expected the system will enable the valid comparison between the rock sample permeability and in-situ measurement in borehole.

PNC also considers to establish the system which takes account into high temperature condition.