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Volunteer Your Time to Serve INMM

The focus of my message this issue is to encourage you to volunteer to serve INMM and help your Institute grow even stronger. During my years as a member of INMM, I have seen a number of excellent changes in INMM — all of them intended to provide better services to its members and create an enhanced environment to better enable all of us to grow professionally. Several years ago, INMM restructured into six technical divisions, resulting in a stronger organization to serve its members. These technical divisions have positioned INMM to handle inevitable and continual changes in the field of nuclear materials management in a proactive and managed fashion.

INMM's technical divisions and the chairs who oversee them are:

- International Safeguards, Chair: Cecil Sonnier, 505/298-1248
- Materials Control and Accountability, Chair: Dennis Brandt, Los Alamos National Laboratory, 505/667-0645
- Nonproliferation and Arms Control, Chair: C. Ruth Kempf, Brookhaven National Laboratory, 516/344-7226
- Packaging and Transportation, Chair: Bill Cole, JAI Corp., 202/479-2116
- Physical Protection, Chair: Steve Ortiz, Sandia National Laboratories, 505/845-8098
- Waste Management, Chair: Ed Johnson, JAI Corp., 703/359-9355

In addition to the technical divisions, there are a number of standing committees that also serve important roles in the institute. These committees include:

- Annual Meeting Oversight, J.D. Williams, Sandia National Laboratories, 505/845-8766
- Technical Program Committee, Charles Pietri, HITECH Consultants, 708/246-8489
- Exhibits, Ken Ystesund, Sandia National Laboratories, 505/844-4388
- Registration, Chris Hodge, USEC, 925/443-1983
- Bylaws and Constitution, Roy Cardwell, 423/986-7347
- Awards, Yvonne Ferris, GEM Technology, 301/903-6619
- Fellows, Sheldon Kops, 312/761-0644
- Communications, Cathy Key, Lockheed Martin Energy Systems, 423/576-6902
- Government/Industry Liaison, John Matter, Sandia National Laboratories, 505/845-8103
- Membership, Nancy Jo Nicholas, Los Alamos National Laboratory, 505/667-1194
- Long-range Planning, Obie Amacker, Pacific Northwest National Laboratory, 509/372-4663

The INMM also serves as the secretariat for two ANSI standards. The INMM chairs for these two committees are:

- N14 — John Arendt, John Arendt Associates, 423/483-1401
- N15 — Joe Rivers, SAIC, 301/353-0172

These are just a few of the dedicated people who volunteer their time to serve the INMM. All of them help you as a member in many ways — but they could be even more effective with your active participation. I would like to encourage you to contact one of these individuals and volunteer to get involved with a committee that interests you.

I mentioned in my column last issue that INMM was facing many new challenges. INMM has a unique contribution to make to nuclear materials management. It is up to all of us to help INMM demonstrate its ability to meet and channel change.

Please volunteer your time to INMM. It is your organization, and it can be made even better by *you*.

As always, I welcome your comments — especially those volunteering your time and talents.

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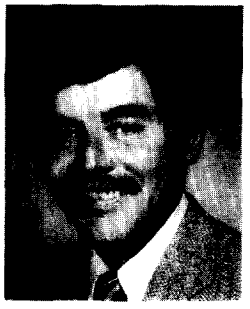
Waste Management Seminar Yields Valuable Insights, Timely Analysis



This issue of the *Journal* contains four articles that were nominated by Ed Johnson, chair of the Waste Management Technical Division. These papers were presented at the INMM Spent Fuel Management Seminar XVI, held in Washington, D.C., in January of this year.

I found all these articles to be interesting reading. Leif Eriksson, in his paper "The Waste Isolation Pilot Plant Transuranic Waste Repository: A Sleeping Beauty," provides us with exacting details of the efforts engaged in the decision process for the opening of WIPP. He also includes a nice dialog of the safe disposal of transuranic radioactive waste in the United States in football/soccer terms. Please appreciate that Leif's paper was written and presented early in 1999, prior to the sleeping beauty receiving the kiss from her prince. He will be presenting the next chapter of the story, in light of the opening of WIPP, during the INMM Annual Meeting.

"Further Research in CRIEPI for the Storage of High Burn-up and MOX Spent Fuel," written by H. Yamakawa, M. Wataru and T.S. Aegusa of the Central Research Institute of Electric Power Industries of Japan provides insight into the research and development activities in Japan that have been carried out to support interim storage of high burn-up and MOX spent fuel. The supposed delay in the plans to increase reprocessing capabilities in Japan makes the importance of this work more significant.

One would initially think that the movement of nuclear material (high-enriched uranium, some low enriched uranium and some spent fuel) from the Republic of Georgia to Dounreay, Scotland, would be "a simple thing to do." When you read the article by Thomas Shelton et al on the U.S.-led effort to remove HEU/LEU fresh and spent fuel from Georgia to Scotland, the story that unfolds is anything but simple. I found the route flown from Georgia to Scotland (see page 28) to be interesting.

The final paper is a running list of legal highlights that have influenced the spent fuel industry's battle on the acceptance of spent fuel since the mid-1990s. These highlights focus on industries' response to the Department of Energy defaulting on their obligation to accept spent fuel. The article lists the points made by Jay Silberg in his presentation at the Spent Fuel Management Seminar. In his title, Jay asks, "Is there an appropriate remedy?" His paper offers no answer; however, it does indicate the actions of industry to force a remedy. Is there a second sleeping beauty somewhere in Nevada?

More JNMM News

As I mentioned in the last issue of the *Journal*, we are about to launch the peer review process. I plan to inaugurate the system with the fall 1999 issue. At the annual meeting of the INMM in Phoenix, I will meet with the associate editors and we will come to closure on the details of the process. I provided a brief summary of that process in the last issue. In the fall issue I hopefully will provide a more detailed description. Should you want to be involved as a peer review volunteer, please contact the associate editor covering your field of expertise. (See page 1 for the list of associate editors.)

I look forward to the annual meeting in Phoenix. Should you want to discuss any *JNMM* issues or provide suggestions or criticisms, please feel free to seek me out.

As always, I welcome any comments or suggestions you may have.

Dennis L. Mangan
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Technical Divisions

Nonproliferation and Arms Control

An exciting transition has begun for the INMM community. For several years, the progress in nuclear materials safeguards in the republics of the former Soviet Union has been reported on at the INMM annual meetings. Typically, we have had five to seven full sessions on this topic, sponsored jointly by this division and the Materials Control and Accounting and Physical Protection technical divisions. The papers were, generally, progress reports on the cooperation during the year since the last annual meeting. This year, papers have tended to two general categories: (1) evaluation/lessons learned and forward-looking papers and (2) particular safeguards aspects of a given cooperative project.

The first type of papers will be given in four sessions, covering the entire MPC&A program. The latter-category papers have been placed, depending on the particular safeguards focus, within the appropriate MC&A or Physical Protection sessions. For example, a paper discussing nuclear material measurements at Chelyabinsk-70 would appear in a nuclear materials measurement session under MC&A sponsorship. So don't be surprised to find papers on former Soviet Union facilities dispersed throughout the program.

At this year's division meeting on Sunday, July 25, I would like to focus our discussions on two main subjects: (1) planning for a workshop in spring of 2000 and (2) nonproliferation implications of "exposure" of sensitive nuclear weapons information in the international community. Perhaps there are evolving roles to be played by specialists from the INMM community.

At this year's annual meeting, on Wednesday, July 28, there will be a special breakout session on lessons learned and brainstorming relating to MPC&A. We plan to have a panel of invited speakers, including representatives from nongovernmental organizations, the United States and FSU republics, speak on a set of evolving issues in the MPC&A area. The chair will challenge the audience, which will be formed into three or more breakout groups, to discuss and develop lessons learned, options, responsibilities, etc., for each of the issues identified. The groups will alternate presenting their findings by topic to the remainder of the audience members, who will then participate in questions, answers, additions, revisions, etc. Finally, the panel will reconvene and the chair, with panel comment, will summarize the session results. We hope this will be an opportunity for frank, open sharing and the development of fresh approaches to some potentially knotty problems.

C. Ruth Kempf
Chair, INMM Nonproliferation and Arms Control Technical Division
Brookhaven National Lab
Upton, New York, U.S.A.

Packaging and Transportation

The Packaging and Transportation Division will hold a meeting in Phoenix during the INMM Annual Meeting to discuss plans for hosting a P&T seminar/symposium. The discussions will focus on ideas for seminar/symposium content, format and logistics. Those interested in participating should contact Billy Cole (202/479-2116) or Scott Vance (208/463-1503) for specifics on time and place.

Billy Cole
Chair, INMM Packaging and Transportation Technical Division
JAI Corp.
Fairfax, Virginia, U.S.A.

Chapters

Japan

The INMM Japan Chapter will hold its 20th Annual Meeting in Tokyo Nov. 4–5. The first day will feature a plenary session including invited lectures and a panel discussion tentatively titled "Peaceful Use of Atomic Energy and Nuclear Materials Management in Asian Region." The panelists will be invited from various Asian countries. The second day will feature technical sessions. A simultaneous interpretation service will be provided during the plenary session. M. Akiba of the Nuclear Material Control Center in Tokyo is the program chair.

The 9th Workshop was held in Tokyo June 14 to discuss the following subjects:

1. Implementation of strengthened and streamlined safeguards in Japan.
2. Safeguards information analysis technique in the future.

Takeshi Osabe
Secretary, INMM Japan Chapter
Nuclear Material Control Center
Tokyo, Japan

Northeast

New officers of the Northeast Chapter who were elected to the Executive Committee for 1998–1999 are Ken Sanders, president; Joseph Indusi, vice president; Teri Westerfeldt, treasurer/secretary; Bruce Moran, treasurer; Charles Emeigh and David Dougherty, members-at-large. Michael Heaney and Amy Whitworth will continue as members-at-large also. The new officers thank the outgoing officers, Yvonne Ferris and David Crawford, members-at-large, for serving the chapter well during its inaugural year.

The chapter sponsored a luncheon meeting at the U.S. Department of Energy April 12. The speakers at the meeting, both from the Institute for Science and International Security, were Khidhir Hamza, physicist and senior fellow, and David Albright, president. Hamza's presentation addressed Iraq's clandestine nuclear weapons development program as it existed prior to and after the Persian Gulf War. Albright gave a provocative overview of issues and led a lively discussion with questions and answers.

The chapter Executive Committee is continuing to plan and sponsor a workshop on implementation of the new additional protocol for a strengthened IAEA safeguards system. This protocol was signed by the U.S. in 1998, is expected to be ratified in 1999, and will potentially affect many U.S. facilities.

The chapter Executive Committee unanimously approved contributions to the INMM Memorial Fund for three highly respected members of the INMM: Len Brenner, George Kuzmycz and Robert Sorenson. The former two are from the Northeast Chapter.

The next chapter meeting will take place in the fall at Brookhaven National Laboratory in Upton, New York, with a tour of the laboratory.

Kenneth Sanders
President, INMM Northeast Regional Chapter
U.S. Department of Energy
Washington, D.C., U.S.A.

Russian Federation

During the period covered by this report, the INMM Russian Federation Chapter continued to form its membership. Chapter members took active part in different procedures related practically to all spheres of INMM activity. At present, the chapter includes 16 registered members from 11 official (Minatom, Gosatomnadzor, etc.) and unofficial agencies of different Russian regions (Moscow, the Urals, Nizhny Novgorod). Eventually, we will have established a complete order of procedures for creation of a chapter database and inclusion in the INMM database.

In 1999 chapter management has followed the earlier accepted policy aimed at the involvement of the most active experts from various Russian regions (the Urals, Siberia) as INMM members. In particular, the chapter accepted four new members from Siberia, the Urals and Moscow. These persons, in most cases, are active participants in the Russian-American cooperation under the MPC&A program.

As the number of members and the number of Russian regions that are involved in chapter activities increases, a question of regional chapter establishment can be raised. They can be established either under the auspices of the Russian Federation Chapter (centralized version) or on an independent basis (decentralized version). In the case that the latter version is approved the Russian Federation Chapter of INMM may be renamed as the Moscow Chapter or Central Chapter and include INMM members who live and work in the Moscow region. However, the time required for these changes is estimated at two to three years.

Members of the Russian Federation Chapter of the INMM took active part in activities in Russia and abroad:

The publishing of a book by R. Timerbaev (chapter vice president), titled *Russia and Nuclear Nonproliferation, 1945–1968*, became a remarkable event. This book will be presented in Vienna (IAEA) and in Obninsk jointly with the Obninsk Regional Chapter of the INMM.

The following should be pointed out among other activities performed by Russian Federation Chapter members:

- Performance of activities under more than 50 contracts in compliance with the Russian-American MPC&A Agreement;
- Preparation and conducting of activities under Russian-American Nuclear Security Council (V. Sukhoruchkin);

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N14 Technical Committee — Packaging and Transportation of Radioactive and Non-nuclear Hazardous Materials

The N14 Annual Meeting was held Nov. 5, 1998, at the Department of Transportation Nassif Building in Washington, D.C. Meeting minutes were distributed to the membership. An updated Status of Standards follows.

N14.1 — 1995 Packaging of Uranium Hexafluoride for Transport
R.I. Reynolds, chair
Standard provides criteria for packaging of uranium hexafluoride for transport. Revision of this standard is currently underway. The chairman has issued 56 potential changes for writing group consideration. A meeting of the writing group will be held May 19–20, 1999, to finalize a draft for N14 balloting.
Estimated completion date: 2000

N14.5 — 1997 Leakage Tests on Packages for Shipment
L.E. Fischer, chair
This standard specifies methods for demonstrating that Type B packages comply with the package containment requirements of Title 10 of the Code of Regulations, Part 71, September 1983, as amended, or of the International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1985, or verification, and periodic verification. ANSI approved the standard Feb. 5, 1998.

N14.6 — 1993 Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More for Nuclear Materials
George Townes, chair
This standard sets forth requirements for the design, fabrication, testing, maintenance and quality-assurance programs for special lifting devices for containers weighing 10,000 pounds (4,500 kg) or more for radioactive materials. Review for an update will start in 2000.
Estimated completion date: 2001

N14.24 — 1985 (R1993) Domestic Barge Transport for Highway Route Controlled Quantities of Radioactive Materials
David L. Cummings, chair
This standard identifies the organizations, equipment, operations and documentation that are involved in domestic (i.e., between U.S. ports) barge shipments of highway-route controlled quantities of radioactive material on inland waterways and in coastwise and ocean service. A writing group has been formed and the revision process has started.
Estimated completion date: 2001

N14.27 — 1986 (R1993) Carrier and Shipper Responsibilities and Emergency Response Procedures for Highway Transportation Accidents
Bill Pitchford, co-chair
Ella McNeil, co-chair
The scope for this standard encompasses the preparation and execution by carriers and shippers of their emergency response program. It does not include the responsibilities of the first-on-the-scene response personnel, the actions of governmental authorities or the specific responsibilities of the carrier or shipper during recovery operations. Writing group co-chairs have been appointed. Planning has started on a new scope for an extensive revision. A writing group is being formed.
Estimated completion date: 2001

N14.29 — 1998 Guide for Writing Operating Manuals for Packaging
Dennis McCall, co-chair
Mike Burnside, co-chair
This guide describes the preparation and distribution of operating manuals for the use, maintenance and inspection of packages for shipping radioactive material. It prescribes the contents of such a manual and their arrangement, and contains a sample manual that can be used as a model. A draft has been prepared and is being reviewed internally before being sent to the writing group for review and approval.
Estimated completion date: TBD

N14.30 — 1992 Design, Fabrication and Maintenance of Semi-Trailers Employed in the Transport of Weight-Concentrated Radioactive Loads
Ralph Best, chair
This standard established the design fabrication and maintenance requirements for the highway transport of weight-concentrated radioactive loads. A weight-concentrated load is any payload that exceeds 1,000 pounds per linear foot over any portion on the semi-trailer. In addition, the standard provides detailed procedures for in-service inspections, testing and quality assurance. Revision of this standard was started in 1998. The chair collected information for a proposed revision and a meeting of the writing group was held Oct. 22–23, 1998.
Estimated completion date: 2001

Projects that are currently under development and may result in standards after approval by ANSI and N14:

Tiedowns for Transport of Fissile and Radioactive Containers Greater than One Ton in Truck Transport
R.E. Glass, chair
This standard prescribes general requirements for securing packages of radioactive materials so they are not likely to come off their vehicles in the worst nonaccident events of highway transportation. In accidents, packages secured as prescribed in this standard may come off their vehicle. The draft has been completed. N14 balloting currently is in process, to be completed April 23, 1999.
Estimated completion date: 1999

Guide to the Design and Use of Shipping Packages for Type A Quantities of Radioactive Materials
R.B. Pope, chair
This standard provides guidance for persons responsible for activities involving the packaging of radioactive materials in Type A quantities. Its major topics

include: (a) definitions, (b) description, (c) responsibilities, (d) quality assurance, (e) design, (f) fabrication, (g) regulatory requirements, (h) use and (i) reuse. The initial document was developed using EM-76 funding. Comments on the initial draft were obtained from the writing group in 1995. However, since that time, due to changing chairmanship and limited resources, no further activities have occurred. The documentation supporting the further development of this standard has been archived at Oak Ridge National Laboratory. The development of this standard is expected to continue beginning in late 1999. The current chair will also coordinate with the chair of the N14.26 writing group. The N14.7 writing group will revise the standard in accordance with comments received and will have the standard ready for submittal for N14 balloting approximately one year after work is reinitiated. The efforts here could also be applied to the lesser types of packages [i.e., to strong-tight packages and industrial packages].
Estimated completion date: 2001

N14.23 Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport
Ken Gwinn, chair
This standard specifies minimum design values for shock and vibration in highway transport, by truck or tractor-trailer combination, for radioactive materials when package weight exceeds one ton. A final draft has been approved by the N14.23 Committee. Balloting was completed Dec. 1, 1998. Negative ballots are currently being resolved.
Estimated completion date: 1999

N14.26 Fabrication, Inspection and Preventative Maintenance of Packaging for Radioactive Materials
Kevin Nelson, chair
This standard provides requirements for the fabrication, maintenance and inspection of reusable Type A packages (nonfissile) to ensure the packaging is (1) properly fabricated in accordance with appropriate specifications, (2) properly maintained, (3) properly inspected and (4) properly assembled for shipment. A new chair has been appointed and a writing group is being formed.
Estimated completion date: TBD

N14.31 Standard Tiedowns on Legal Weight Transport System (80,000 Pounds) for Packages Containing Hazardous Materials and Weighing Greater than 500 Pounds
Larry Shappert, chair
This standard provides a method for defining an appropriate tiedown system through the use of a simple, computer-based tiedown stress calculation program. The standard describes general requirements for securing hazardous materials packages to conventional trailers. The packages have a suitable base plate (pallet or skid) or flat base, and appropriate size and arrangement of tiedown assemblies for packages that are within the weight and dimensional limits of the equipment. The writing group commented that the text and computer model need work. The IAEA recently modified package securement requirements (ST-2, 1998), and results need to be considered in modifying the draft standard. Work has been on hold since FY1996, when EM-76 funding was terminated. When funding is provided, the work could be completed and a standard put forward for balloting by the

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N14 Technical Committee

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N14 Committee in a time period of 14 to 18 months.
Estimated completion date: TBD

N14.32 Gas Generation in Packages Used for the Storage or Transport of Radioactive Materials
L.E. Fischer, chair
The scope of this standard is gas generation in packages used for the transport or storage of radioactive materials. This standard includes, but is not limited to, the following gas-generation mechanisms: radiolysis, chemical reactions, thermal expansion and biological degradation. This standard will provide a consistent approach to testing, analysis and mitigation of gases that could cause a pressure buildup or a potentially flammable mixture in a package containing radioactive materials. A project initiation notification system form has been prepared. N14 balloting of title and scope was completed and approved with a few comments. A writing group has been formed, and work has started on preparing the final draft.
Estimated completion date: 2000

Projects that are currently inactive:

Fabricating, Testing and Inspection of Shielded Shipping Casks for Irradiated Reactor Fuel Elements
D. Dawson, chair
This activity will utilize the peer panel review to determine standards that should be developed. It currently is not active. It will be activated when documents are received for standards consideration. Completion dates will be set for each document received.
Estimated completion date: N/A

N14.10 Guide for Liability and Property Insurance Aspects of Shipping Nuclear Materials
This guide discusses conventional liability (general liability and automobile liability), insurance policies and the attendant nuclear liability exclusion (Broad Form) as they apply to nuclear liability arising out of the transportation of nuclear material. It will be reactivated when a need arises.
Estimated completion date: N/A

Ancillary Features of Irradiated Shipping Casks (formerly N14.19)
This standard sets forth requirements for the performance, design, fabrication, testing, operation, maintenance and quality assurance of the ancillary features of irradiated fuel shipping casks. The standard has been withdrawn. The need for this standard is questionable. Possible adoption of ISO standard on trunnions (TC85/SC5/WG9).
Estimated completion date: N/A

N14.25 Tiedowns for Rail Transport of Fissile and Radioactive Material Containers
Bob Glass, chair
This standard applies to attachment or tiedown of containers of radioactive materials to railroad cars where the gross weight of the containers exceeds one ton. The chair has prepared a preliminary draft that was sent to the N14 Management Committee for its review and comment. A project initiation notification system will be prepared for submittal to ANSI. The scope will be sent to the N14 Committee for approval prior to submitting to ANSI.
Estimated completion date: TBD

John Arendt
Chair, INMM N14 Technical Standards Committee
John Arendt Associates Inc.
Oak Ridge, Tennessee, U.S.A.

The Waste Isolation Pilot Plant Transuranic Waste Repository: A Sleeping Beauty

Leif G. Eriksson
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Albuquerque, New Mexico, U.S.A.

Abstract

On May 13, 1998, crowning a 24-year United States Department of Energy effort, the U.S. Environmental Protection Agency certified[1] that the deep geological repository for safe disposal of long-lived, transuranic radioactive waste proposed by the DOE at the Waste Isolation Pilot Plant site in New Mexico (Figure 1) complied with all applicable environmental radiation protection standards[2] and compliance criteria.[3] Pursuant to the applicable law, the WIPP Land Withdrawal Act of 1992,[4] as amended in 1997,[5] at the decision of the secretary of energy, the WIPP repository could open 30 calendar days after receiving the EPA certification. The secretary of energy announced May 13, 1998, that he intended to open the WIPP TRUW repository by June 14, 1998. However, at the end of 1998, the opening of the WIPP TRUW repository remains hostage to time-consuming, hazardous-waste-permitting procedures by the state of New Mexico Environment Department and two legal actions. Based on the EPA-verified high safety and the demonstrated risk reduction to both current and future generations offered by the WIPP TRUW repository, it is concluded that the WIPP TRUW repository is a sleeping beauty that will awake, perhaps in stages, and begin its important mission in 1999.

Introduction

In the United States, the safe disposal of long-lived radioactive wastes, i.e., TRUW and spent nuclear fuel and other high-level radioactive wastes, is governed by two different sets of laws and regulations. Furthermore, although the DOE is the federal agency responsible for the safe disposal of both TRUW and HLW, the related disposal programs are managed by two essentially autonomous and unconnected offices of the DOE: the Carlsbad Area Office and the Office of Civilian Radioactive Waste Management, respectively. The remainder of this text only addresses the TRUW disposal program and begins with a background section outlining:

(1) The legal and regulatory frameworks for safe disposal

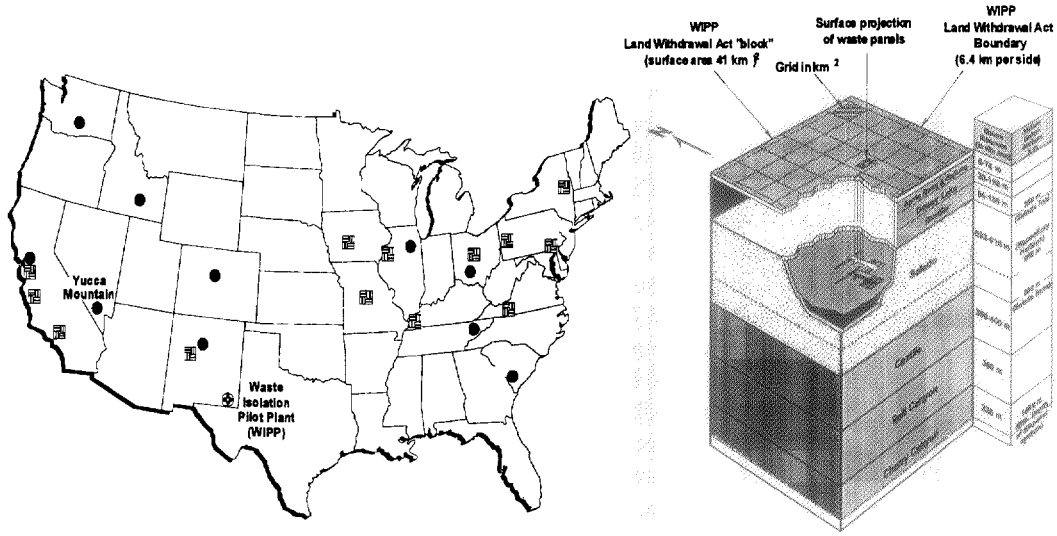


Figure 1.

Locations of the United States' 10 large-quantity (circles) and 13 small-quantity (squares) transuranic waste generator/storage sites, the Waste Isolation Pilot Plant site and the Yucca Mountain candidate high-level radioactive waste repository site.

of TRUW;

(2) Select key regulatory safety concepts and requirements (including three definitions of safety);

(3) Vital statistics for the WIPP site (population statistics, geologic units/formations [stratigraphy], existing facilities and main cost/budget items);

(4) The 1993 establishment of the Carlsbad Area Office and its main achievements by the end of 1998 (including select successful CAO strategies contributing to the almost three-year advancement of the certification of the WIPP TRUW repository and the CAO's path forward).

A discussion section mainly addressing the risk reduction the WIPP TRUW repository offers to current and future generations and environments follows the background section. The emphasis of both the background and discussion sections is on the long-term safety/risks of the WIPP TRUW repository. A summary section with the author's main observations and conclusions concludes the main text. Key terms used in the text are indicated in italics.

Background

Legal and Regulatory Frameworks for Safe Disposal of Transuranic Waste

The legal framework for safe disposal of transuranic radioactive waste is embodied in the Land Withdrawal Act[4], as amended in 1997.[5] The LWA directs the DOE to develop and operate a deep geological repository for safe disposal of *defense-generated* TRUW at the WIPP site (Figure 1) in compliance with the environmental radiation protection standards, hereinafter referred to as *the disposal regulations*, to be repromulgated by the EPA. The EPA repromulgated the disposal regulations in December 1993[2] and promulgated criteria for compliance with them in February 1996.[3]

The above legal and regulatory frameworks allow for up to 175,584 m^3 (6.2 million ft^3) of TRUW to be disposed of in the WIPP repository. They also define and limit the volume of two different TRUW categories that may be disposed of in the WIPP repository. Pursuant to the LWA (and the disposal regulations) TRUW contains at least 3,700 Bq (100 nCi) of alpha-emitting transuranic isotopes per gram of waste having a half-life greater than 20 years, but the maximum surface dose rate may not exceed 10 Sv/h (1,000 rem/h). There are two TRUW categories: contact-handled and remote-handled. *CH-TRUW* ranges from 3,700 Bq (100 nCi) per gram of waste to a maximum surface dose rate of 0.002 Sv/h (0.2 rem/h). *RH-TRUW* ranges from a surface dose rate greater than 0.002 Sv/h (0.2 rem/h) up to 10 Sv/h (1,000 rem/h). In addition, there are upper limits on the RH-TRUW both in terms of maximum activity level per liter averaged over the volume of the canister (8.51×10^{11} Bq [23 Ci]) and the total RH-TRUW activity level (18.87×10^{16} Bq [5.1 million Ci]).

In a separate consultation and cooperation agreement with the state of New Mexico,[6] as amended, the DOE has agreed to limit the RH-TRUW volume to 7,080 m^3 (250,000 ft^3), of which only 354 m^3 (12,500 ft^3) may exceed a surface dose rate of 1 Sv/h (100 rem/h). As follows, if filled to capacity, at least 96 percent of the disposed TRUW volume, i.e., 168,504 m^3, will be CH-TRUW that can be handled safely without any protective clothing or shielding, less than 4 percent will be RH-TRUW, and only up to 0.2 percent of the total TRUW volume or 5 percent of the RH-TRUW volume will exceed a surface dose rate of 1 Sv/h (100 rem/h).

About 60 percent of the existing TRUW (106,000 m^3 [3,743,000 ft^3]) is mixed with regulated hazardous constituents/waste *(mixed TRUW)* that are governed by a different set of laws and regulations and a different regulator than the nonmixed TRUW. The Resource Conservation and Recovery Act of 1976[7] is the main applicable hazardous waste law. Although the EPA promulgated the RCRA-related hazardous waste disposal regulations,[8-10] the permitting and oversight authority for hazardous waste receipt, handling, and disposal at the WIPP site has since been transferred to the New Mexico Environment Department.

As follows, for the DOE to open and operate the WIPP TRUW repository to full capacity, i.e., to dispose of both nonmixed and mixed TRUW, the EPA needs to *certify* that TRUW may be safely disposed of, and the NMED needs to issue a *permit* for receipt, handling, storage and disposal of the hazardous constituents in the mixed TRUW at the WIPP site. The DOE's interpretation of current laws and regulations is that *the WIPP TRUW repository may open for disposal of nonmixed TRUW pending the NMED's issuance of the hazardous waste permit*, and it is vigorously pursuing the phased opening of the WIPP TRUW repository.

Select Key Regulatory Safety Concepts and Requirements

On May 13, 1998, the EPA certified that the WIPP TRUW repository complied with all applicable disposal regulations.[2,3] As described and discussed below for seven select examples, these regulations contain very stringent, prescriptive and globally unique safety criteria and concepts:

(1) *The regulatory period* for environmental radiation protection of future generations and environments *is limited to the 10,000 years* following the closure of the repository.

(2) The first 100 years of the regulatory period is referred to as the *active institutional controls period*, which is followed by the 9,900-year *passive institutional controls period*, i.e., the regulations assume that institutional controls will be lost no later than 100 years after the closure of the repository. The compliance criteria suggest that the institutional controls period may be extended beyond 100 years, but the EPA declined this option in the DOE's compliance certification application[14] for the WIPP repository in the certification.[1]

(3) The postulated safety basis for the disposal regulations is 1,000 repository-induced cancer deaths during the 10,000-year regulatory period among a global population of 10 billion people, i.e., one death among 100 bil-

lion people, which equates to a repository-induced cancer-death risk of 10^{-11}.[11] As follows, the probability is 7×10^{-9} that a person living for 70 years at the boundary between the *controlled area* and the *accessible environment* would die from repository-induced cancer, which is at least three orders of magnitude, i.e., 1,000 times, more stringent/restrictive than the risk factors used by any other country or any recommendation issued by the International Atomic Energy Agency[12] and the International Commission on Radiological Protection,[13] and, as illustrated in Table I, between four and nine orders of magnitude lower than the risks from other common activities/hazards.

Table I. Probability of death and comparable number of deaths for a deep geological TRUW or HLW repository and some select common activities/hazards

Activity/Hazard	Probability of Death	Related Deaths
Repository (10 CFR Part 191)	1 in 100,000,000,000 people	1
Bee sting	1 in 5,000,000 people	20,000
Being struck by lightning	1 in 2,000,000 people	50,000
Flying	1 in 833,000 people	120,048
Walking	1 in 54,000 people	1,851,185
Cycling	1 in 26,000 people	3,846,154
Driving a car	1 in 5,700 people	17,543,859
Riding a moped	1 in 5,000 people	20,000,000
Riding a motorcycle	1 in 1,000 people	100,000,000
Smoking 20 cigarettes per day	1 in 200 people	500,000,000

(4) Safety is defined both in terms of (a) the total amount of radionuclides passing the boundary between the controlled area and the accessible environment *during the 10,000-year regulatory period* and (b) the maximum *annual* radiation dose to an individual. Whereas the maximum annual dose to an individual is limited to 0.15 mSv (15 mrem) and *undisturbed conditions* (when the repository is only affected by natural features, events and processes [FEPs]), the total/cumulative amount of radionuclides that may be released to the accessible environment under undisturbed and *disturbed conditions* (when the repository is affected by low-probability, hypothetical, human-induced FEPs) is directly proportional to the amount of radioactive waste emplaced in the repository.[2]

(5) The horizontal projection of the controlled area, which hosts the repository, may not (a) exceed 100 km^2 (38.6 mi^2), (b) extend beyond the center of the planet Earth or (c) extend more than 5 km (3.1 mi) beyond the perimeter of the emplaced TRUW. As schematically illustrated in Figure 1, the horizontal projection of the controlled area at the WIPP site, i.e., the WIPP Land Parcel, is only 41.6 km^2 (16 mi^2), the depth is only 1,970 m (6,000 ft), and the distance between the perimeter of the emplaced TRUW and the accessible environment is only 2.4 km (1.5 mi). The significant implication of this condition is that the WIPP performance assessment results reported and discussed below are based on a radionuclide containment and isolation rock volume less than half of that permissible by the applicable regulation.

(6) Stochastic/probabilistic-based performance assessments are mandated to predict the long-term (post-closure) safety/risk/performance of the repository in terms of complementary cumulative distribution functions (CCDFs) for radionuclide releases to the accessible environment during the 10,000-year regulatory period. It should be noted that, during the 100-year active institutional controls period, only natural FEPs need to be considered. However, both natural and low-probability, hypothetical, human-induced FEPs with a probability of occurrence greater than one chance in 10,000 during the 10,000-year regulatory period, i.e., the probability of occurrence is 10^{-8} or greater, must be considered during the 9,900-year passive institutional controls periods.

(7) The performance assessments for both undisturbed and disturbed conditions must include the 99th percentile of the population of all scenarios (combinations of FEPs) with a 95-percent confidence level. The confidence level in the mean CCDF has to be at least 95 percent.

Vital Statistics for the Waste Isolation Pilot Plant Site

The WIPP site is located in the state of New Mexico (Figure 1) about 42 km (26 mi) southeast of the city of Carlsbad in a semi-arid and sparsely populated area. Fewer than 30 permanent residents live within a 16-km (10-mi) radius of the WIPP site, and fewer than 100,000 permanent residents live within an 80-km (50-mi) radius.

The regional geological setting at and adjacent to the WIPP site consists of a lacustrine sequence of evaporites with local economic gas and oil deposits. As illustrated in Figure 1, the WIPP repository is located about 650 m (2,150 ft) below the ground surface in the lower half of a 250-million-year-old, regionally extensive, undisturbed and virtually impermeable 600-m (2,200-ft) thick, bedded rock salt (mainly halite) formation. As also illustrated in Figure 1, the square WIPP land parcel, which defined the horizontal projection of the controlled area, measures 6.4 km × 6.4 km (4 mi × 4 mi), for a total area of 41.6 km^2 (16 mi^2) and the maximum lateral distance between the perimeter of the emplaced TRUW and the accessible environment of 2.4 km (0.93 mi). The horizontal projection of the repository area is only 0.5 km^2 (0.19 mi^2).

All surface and subsurface facilities, equipment and trained personnel were in place in 1988, but evolving laws, regulations, DOE policies, legal actions and the NMED's time-consuming processing of the permit have repeatedly deferred

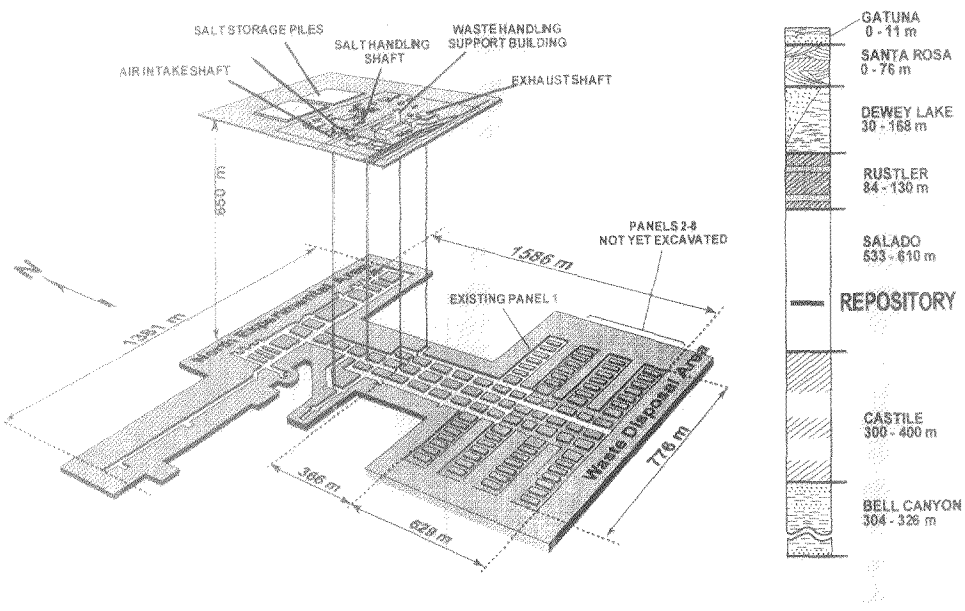


Figure 2. Schematic illustration of the baseline repository and the North Experimental Area layouts and the stratigraphic column at the WIPP site.

the opening of the WIPP TRUW repository. As illustrated in Figure 2, four shafts connect the repository and the surface facilities, and the current repository baseline layout includes eight panels. Each panel is divided into seven TRUW emplacement/disposal rooms. Each emplacement/disposal room is 4 m (12 ft) high, 10 m (30 ft) wide, and 91 m (300 ft) long. At the end of 1998, only the northeasternmost panel, panel 1, has been excavated.

The estimated life cycle cost for the WIPP TRUW repository through 2043, including 35 years of operation and another ten years for decommissioning/closing, is in the order of $11 billion. At the end of 1998, approximately $2 billion have been spent to characterize, develop and maintain the WIPP site and its facilities. The CAO's annual budget during the past three years has been in the order of $175 million–$200 million. As follows, the daily cost to the taxpayers to maintain the certified WIPP repository in operationally ready state pending the NMED's issuance of the permit and the resolution of current lawsuits is about $500,000.

The 1993 Establishment of the Carlsbad Area Office and Its Main Achievements by the End of 1998

The DOE established the CAO in December 1993 to execute the TRUW mission outlined in the LWA,[5] i.e., to integrate the management of the nation's TRUW and to develop, operate and decommission the WIPP repository. The establishment of the CAO adjacent to the WIPP site and the appointment of a resourceful and duly authorized CAO manager reinforced the DOE's "unique" partnership with the local communities. Three select CAO strategies vital to the successful three-year advancement of the certification of the WIPP TRUW repository and also contributing to the enhanced regulatory and public confidence in the safety of the WIPP TRUW repository are summarized below.

In April 1994, the CAO published the Disposal Decision Plan (Figure 3) based on a thorough evaluation of conditions, capabilities, and existing and expected TRUW volumes at the nation's TRUW generator/storage sites. The DDP integrated the nation's TRUW-management activities and advanced the projected permitting, certifying and opening of the WIPP TRUW repository almost three years. However, although the WIPP TRUW repository did not open at the date initially scheduled, all CAO-controlled DDP schedule milestones have been met. The only repeatedly slipping schedule milestone of the DDP is the NMED's final ruling on the permit. For example, in 1995, the NMED projected that the final permit would be issued in August 1997. At the end of 1998, the NMED projects that it will issue the final permit between July and September 1999.

Two other successfully developed and implemented CAO strategies are:

(1) The CAO's recognition of the importance of and commitment to early and iterative public interactions with the regulators, oversight groups, and other affected and/or interested organizations and individuals (hereinafter referred to as stakeholders);

(2) The System Prioritization Method.[15]

As illustrated in the stakeholders/oversight portion of Figure 3, 47 public meetings were scheduled and attended by CAO representatives during a five-year period. Several additional public meetings were held to address topical issues of significance to the safety and long-term performance of the WIPP repository and/or major CAO decisions. For example, in 1985, the CAO was represented in 35 public meetings. These early and open CAO interactions with regulators, oversight groups and stakeholders stimulated constructive information exchanges and mutual education and understanding of concerns and issues.

As indicated above, the December 1993 disposal regulations provided the yardstick for the certification of the WIPP TRUW repository. In February 1994, the CAO manager decided to conduct a thorough analysis of the then proposed 116 different scientific activities relative to the criteria and conditions outlined in the disposal regulations. The System Prioritization Method evaluated the 116 scientific activities in more than 46,000 combinations (activity sets) by more than 1,300,000 probabilistic (stochastic) analyses in terms of being able to provide the information required to demonstrate compliance with the disposal regulations. The SPM identified eight main

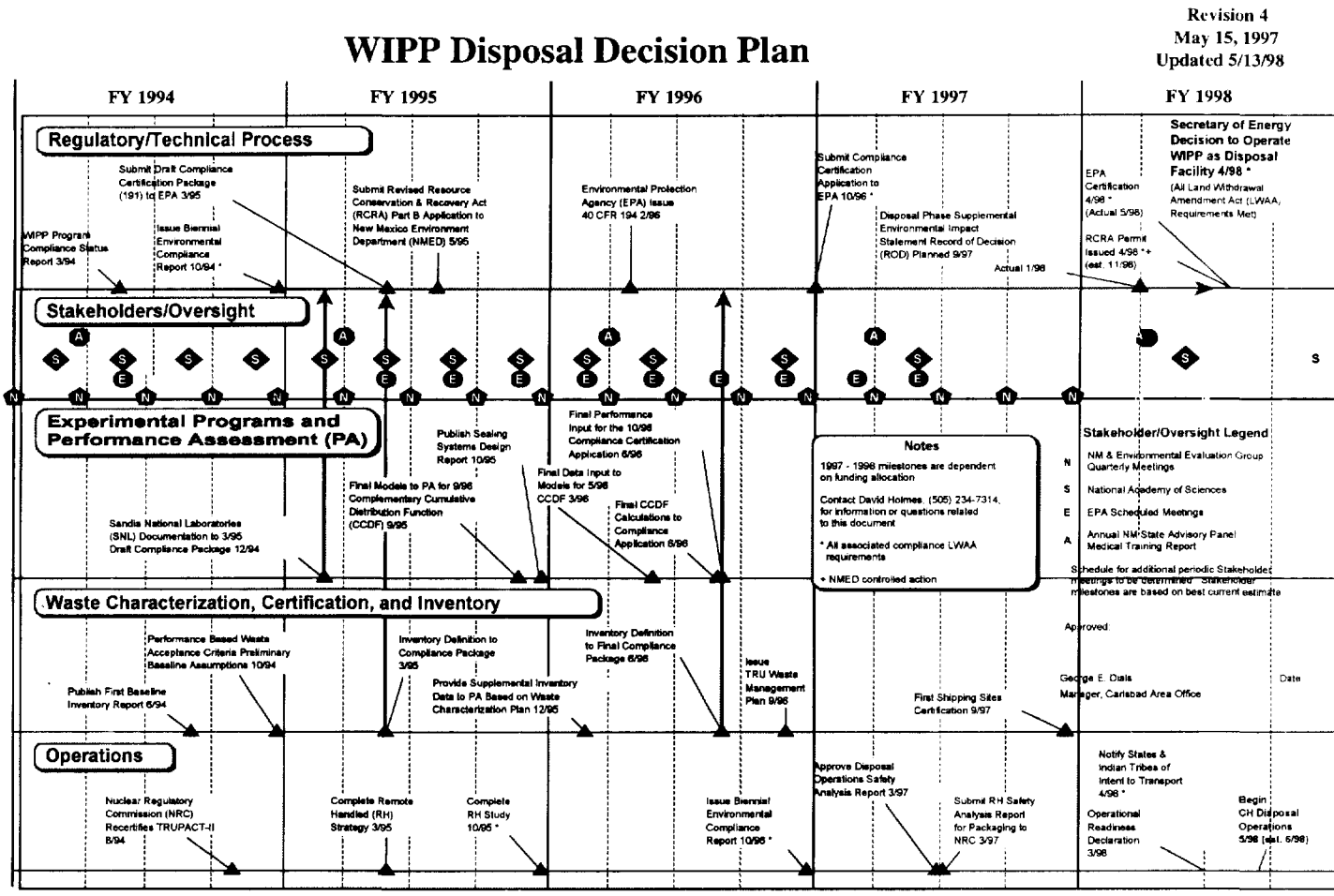


Figure 3. The Waste Isolation Pilot Plant Disposal Decision Plan (Revision 4)

scientific activity sets that, if the outcomes were within the expected ranges, would provide a 96-percent confidence level that the WIPP TRUW repository would comply with the disposal regulations. In August 1995, the manager of the CAO decided to focus the scientific program on the eight activity sets identified by the SPM.[15]

As evidenced by the EPA's 1998 certification of the WIPP TRUW repository, the SPM was key to the CAO's ability to use its limited financial resources in a focused manner to obtain the scientific and engineering information required to certify the WIPP TRUW repository almost three years ahead of the pre-CAO schedule. This advancement represents a potential cost saving to the taxpayers of about $500 million, which is being depleted by the NMED's time-consuming permitting process and two legal challenges. The SPM also provided the CAO manager a credible and transparent basis for defensible decision making.

On Oct. 26, 1996, the CAO submitted the WIPP compliance certification application[14] to the EPA. On May 13, 1998, after 19 months of evaluation of the 84,000-page compliance certification application and some additional 20,000 pages of requested information (including bounding worst-case performance assessment verification tests [PAVT]), the EPA conditionally certified[1] that the TRUW repository complied with all applicable disposal regulations[2] and compliance criteria.[3] One of the conditions was that the DOE must recertify the WIPP TRUW repository at least every fifth year after receiving/disposing the first shipment of TRUW. Opponents to the WIPP TRUW repository and anti-nuclear interest groups and individuals promptly filed lawsuits against both the EPA and the DOE to prevent the WIPP TRUW repository from opening. The lawsuit against the DOE seeks to block the opening of the WIPP TRUW repository until the NMED has issued the final permit. The lawsuit against the EPA challenges both the EPA's certification process and its decision. At the end of 1998, court hearings are scheduled for February 1999 on the lawsuit against the DOE and for May 1999 on the lawsuit against the EPA. It should be noted that two similar lawsuits against the EPA have already been dismissed.

On May 15, 1998, after 36 months of evaluation of the DOE's 11,000-page permit application, the NMED issued a notice of intent to conditionally approve the DOE's permit application. On Nov. 13, 1998, the NMED (a) revised the May 1998 draft permit and (b) outlined a schedule for

the continued permitting process that will last at least until July 1999, including a public hearing process on the modified draft permit beginning Feb. 22, 1999, with an option to reconvene it March 15, 1999.

As noted above, the NMED's schedule for the permitting process has been revised, and the date for the NMED's final ruling on the DOE's permit application has been delayed several times. Thus, pending the NMED's final ruling on the permit application, to minimize the unfavorable cost and population-risk impacts of the repeatedly extended permitting process, the DOE, with the consent of the NMED, decided to open the WIPP TRUW repository and commence disposal of nonmixed TRUW. The main reasons for this revised CAO strategy are:

(1) The risks and safety concerns associated with the hazardous constituents of the mixed TRUW are significantly less than those associated with the radioactive constituents.

(2) The EPA has certified that it is safe to dispose of the radioactive constituents for at least 10,000 years.

(3) The cost to the taxpayers of maintaining the WIPP TRUW repository and the transportation system in active status is about $500,000 per calendar day.

(4) The NMED's past inability and unwillingness to comply with its schedules for the issuance of the final permit provide very low confidence that it will meet the November 1998 schedule.

The DOE's intent to open the WIPP repository for nonmixed TRUW was postponed/delayed by an NMED request for additional waste characterization data. Following a hectic and herculean DOE and Los Alamos National Laboratory planning and waste characterization effort during the summer and fall of 1998, the NMED announced Dec. 2, 1998, that the 116 characterized drums at LANL proposed for the first shipments to the WIPP TRUW repository did not contain any regulated amount of hazardous constituents and, thus, were not regulated under the pending permit. However, again, before the WIPP TRUW repository may open, a federal judge has to rule on petitions filed by the New Mexico Attorney General's office and several anti-nuclear groups against the DOE seeking to block movement of any TRUW until the NMED has issued the final permit. The federal judge's ruling process is scheduled to commence in February 1999. It should be noted that, although the ruling process on the lawsuit filed against the EPA is not scheduled to commence until May 1999, it does not prohibit the DOE from opening the WIPP repository for nonmixed TRUW. Thus, a prompt federal court ruling in favor of the DOE would allow the DOE to open the WIPP TRUW repository in the spring of 1999.

As noted above, the EPA's certification[1] includes the condition that the WIPP TRUW repository must be recertified at least every fifth year after receiving/disposing the first TRUW shipment. The CAO's current recertification strategy is to continue the scientific program/efforts, focusing on reducing the uncertainty and complexity of the WIPP performance assessment. An important element of this "path-forward" strategy is CAO participation in foreign and international programs and projects. The main objectives of the international collaborations are to cost-effectively:

(1) Expand the CAO's current database and in-house knowledge relevant to the safe operation and recertification of the WIPP TRUW repository;

(2) Make the CAO's state-of-the-art knowledge (e.g., data, models, scientists and managers) and facilities (e.g., laboratories and the WIPP site/repository) available to others, because many of the scientific, engineering, socio-economic, legal and political challenges mitigated successfully by the CAO have global implications and applications.

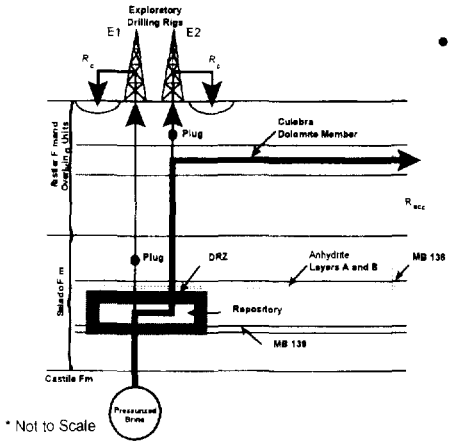
The underlying fundamental principle for the CAO's participation in foreign and international radioactive waste management and disposal projects and programs is that the safe disposal of long-lived radioactive waste is more than a national challenge; it is a global challenge that is best met by international collaborations.

In summation, it took the DOE 24 years to obtain the certification required to open the WIPP TRUW repository and the EPA less than two years to certify that the WIPP TRUW repository/site will safely contain and isolate long-lived radioactive constituents for at least 10,000 years, and it will take the NMED more than four years to rule on whether the WIPP repository/site will safely contain and isolate regulated hazardous waste constituents for up to 35 years. Pending the NMED's final ruling, the CAO will attempt to (a) open the WIPP repository for nonmixed TRUW and (b) continue its domestic research, public interactions and international collaborations aimed at enhancing the safety, credibility and acceptance of the WIPP TRUW repository, the CAO and the deep geological disposal concept in the United States and abroad.

Discussion

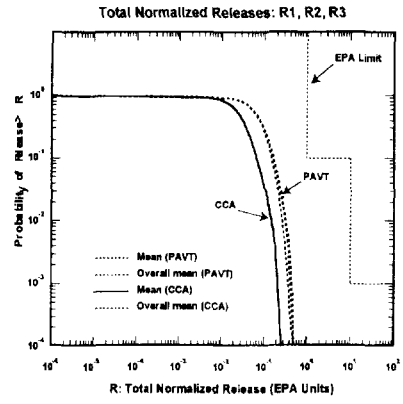
More than 300 FEPs were evaluated in the compliance certification application.[14] These FEPs were studied by means of performance assessments in combinations called scenarios and categorized as either undisturbed (only natural FEPs) or disturbed (both natural and human-induced FEPs). Based on the assumptions, data and models used in the CCA and in subsequent responses to EPA inquiries/requests, virtually no radionuclides will be released to the accessible environment under undisturbed conditions, but disturbed conditions will result in radionuclide releases. For example, the projected maximum annual radiation exposure to an individual from the WIPP TRUW repository is 0.0047 mSv (0.47 mrem), which is 32 times lower than the upper limit of 0.15 mSv (15 mrem) defined in the disposal regulations and 768 times lower than the average annual background radiation in the United States of 3.6 mSv (360 mrem). In other words, the radiation exposure safety factor for the undisturbed WIPP TRUW repository relative to the disposal regulations is at least 32 and relative to the average

CONCEPTUAL MODEL FOR DISTURBED SCENARIO E1 E2



- Disturbed performance assessment consists of:
  - Inadvertent human intrusion
  - Connects repository to Castile brine pocket
  - Considers potash mining
  - Considers all events that have one chance in 10,000 years of occurring
  - Ninety-five percent statistical confidence level in the mean

EPA PERFORMANCE ASSESSMENT VERIFIED REGULATORY COMPLIANCE



- EPA changed 24 parameters after stakeholder consultation and sensitivity studies
- CAO removed Passive Institutional Controls credit

Figure 4. Schematic illustration of the "highest consequence" disturbed scenario and the mean CCDFs for the CCA and the PAVT calculations

annual background radiation in the United States is 768.

In order to address and comprehend the inherent safety of the WIPP TRUW repository, it is important that the "highest consequence" disturbed scenario used in the CCA and the PAVT is understood. This scenario *assumes* that two boreholes penetrate the repository during the regulatory period. For this scenario to result in the highest consequence in terms of radionuclide releases to the accessible environment, the following conditions must be met:

(1) The first borehole must penetrate both the repository and an underlying, *locally occurring*, large, overpressurized brine reservoir, causing brine to inundate the TRUW-disposal room(s), initiating and sustaining chemical reactions with the TRUW, *including inventory-limited dissolution of radionuclides and gas generation.*

(2) The second borehole must penetrate the room(s) or panel(s) affected by the first borehole at the point in time when the chemical reactions resulting from the first borehole is optimally adverse.

As illustrated in Figure 4, the mean CCDFs for disturbed-scenario radionuclide releases projected in the CCA, including the above "highest consequence" scenario and the EPA-requested "worst conceivable conditions," bounding PAVT are well below the radionuclide release limits defined in the disposal regulations. Specifically, the mean CCDFs reported in the CCA show a safety factor of about 20, and the mean CCDFs for the PAVT show a safety factor of at least 10 relative to the applicable regulatory limits.

Clearly, the probability of occurrence for the highest consequence scenario is very low. Furthermore, the assumptions, data and models used in the CCA and the PAVT are very conservative. For example, the rock mass volume of the controlled area is less than half of that upon which the regulatory limits are based, and the WIPP TRUW repository does not rely on any engineered barriers for radionuclide containment and isolation, i.e., all radionuclide containment and isolation are provided by the natural setting at the WIPP site. Consequently, the safety factor for the WIPP TRUW repository, relative to the limits defined in the disposal regulations, is significantly higher than 10 or even 20.

Indeed, as indicated by the domestic and international reviews of the WIPP TRUW repository and its safety case summarized below, the consensus is that the WIPP TRUW repository will safely contain and isolate TRUW. For example, the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine, through the National Research Council's Board on Radioactive Waste Management, established an independent committee on WIPP in 1978. This committee continues to monitor and periodically report on the WIPP project and has issued two main reports and eight additional letter reports between 1979 and 1996. The 1996 report[16] concludes:

> *"For a repository disturbed by human intrusions, when evaluated on the basis of reasonable expectation of intrusive activities and their consequences, and using models that would implement available engineering features and do not make overly conservative assumptions, the consensus of the committee is that the WIPP repository could be shown by DOE to comply with the EPA standard."*

Implicit in this statement is that the DOE has to implement unreasonable expectations, i.e., very low probability disturbed scenarios, and that the assumptions and models used by the DOE are overly conservative. Notwithstanding these widely recognized constraints, as described above, the WIPP TRUW repository readily complies with the disposal regulations.

One international and seven domestic peer reviews were also conducted of the assumptions, data, models and quality assurance used in support of the CCA. For example, the joint international peer review group assembled by the Organization for Economic Cooperation and Development/

Nuclear Energy Agency and the International Atomic Energy Agency reported:[17]

"The IRG concluded that the performance assessment methodology is well founded and has confidence in the majority of judgements and assumptions made in developing the calculational models."

Likewise, with one exception, all seven domestic peer review groups accepted the information provided in the CCA as sound and adequately documented. The only exception was one of the conceptual submodels used to evaluate the potential effects of the second "highest consequence" borehole intrusion. It should be noted, however, that although the conceptual models peer review group rejected this particular conceptual model, the Spallings model, it concluded that the projected amount of released TRUW was conservative and thus acceptable.

Summary of Observations and Conclusions

Figuratively speaking, safe disposal of TRUW in the United States may be described in football/soccer terms as follows:

(1) The 1992 LWA, as amended in 1996, defines the playing field, rules and main players for safe disposal of TRUW in the United States.
(2) The 1993 disposal regulations provide the very narrow goal posts.
(3) The 1996 compliance criteria provide the very low cross bar.
(4) The EPA is the referee.
(5) The DOE fields one team and opponents to the WIPP TRUW repository field the other team.
(6) The stakeholders are the spectators and cheerleaders.
(7) Last but not least, the DOE's strategy must be based on defense, whereas the opposition's strategy may solely rely upon offense, because by the applicable legal and regulatory definitions and contrary to common justice principles the playing field is tilted in favor of the opposition, and the DOE is essentially wrong until proven right.

In this context, the certification of the WIPP TRUW repository is a monumental DOE achievement with global implications. Indeed, despite using overly conservative assumptions and models in the CCA and the PAVT:

(1) The calculated maximum annual radiation exposure to an individual under undisturbed repository conditions is at least 32 times lower than the applicable, very stringent regulatory limit and 768 times lower than the average annual background radiation in the United States.
(2) The calculated maximum cumulative amount of radionuclide releases under undisturbed and disturbed repository conditions is at least 10 times below the applicable regulatory limits.

Two other main observations are:

(1) When in operation, the WIPP TRUW repository will reduce the potential radiation risk to 53 million residents living within 80 km (50 mi) of the 23 TRUW generator/storage sites (Figure 1), of which 17 sites will be free of TRUW by the year 2006.
(2) Every calendar day the opening of the TRUW repository is delayed costs the taxpayers $500,000.

As follows, four main conclusions are:

(1) The WIPP TRUW repository is very safe.
(2) Opposition to the opening and operation of the WIPP TRUW repository has no regulatory or scientific basis and is socially and fiscally irresponsible.
(3) The WIPP TRUW repository will overcome current challenges and open in 1999.
(4) Bedded salt is an excellent geologic medium for containment and isolation of long-lived chemical and radioactive constituents/wastes.

The last main observation is that, as evidenced by case histories in both the United States and abroad, the scientific and engineering challenges involved in the development (siting, site characterization and designs) and opening of a deep geologic repository for long-lived radioactive waste are more readily mitigated than are the politics, dogmas and emotions involved. Three interrelated reasons for this global condition are:

(1) The human and environmental devastations at Hiroshima, Nagasaki and Chernobyl have left the public in the United States and abroad with a lasting stigmatic visual impression and intuitive fear of anything including the words radioactive and/or nuclear.
(2) The science and engineering involved in deep geological disposal of long-lived radioactive wastes are state-of-the-art and, typically, documents and presentations on the subject matter are inundated with scientific and project-specific terms and jargon.
(3) There is a widespread inability and unwillingness among the "proud and peerless" managers and scientists involved in deep geological disposal of long-lived radioactive waste to communicate with the public in layman's terms.

As follows, the very high safety and the very low public-health and environmental risks involved in the regulated disposal of long-lived radioactive wastes in deep geological repositories in the United States and abroad are poorly understood by the general public, making it susceptible to accepting nonfactual information and/or intuitively opposing the unknown. Thus, the last main conclusion is:

To successfully mitigate the widespread, factually unsubstantiated myths, perceptions and fears associated with deep geological disposal of long-lived radioactive waste, it is imperative that all affected and interested parties are adequately informed about the real risks involved in terms that are understood and believed.

In closing, figuratively speaking, the WIPP TRUW repository is a sleeping beauty ready to safely commence full operations in 1999 upon receiving the required kiss from the prince currently engaged in admiring the emperor's new clothes. Upon awakening from its slumber, the WIPP TRUW repository may serve as a role model for the rest of the world.

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Further Research in CRIEPI for the Storage of High Burn-up and MOX Spent Fuel

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Abstract

This paper describes the current research in CRIEPI for the storage of high burn-up and MOX spent fuel carried out in a few years. The main results described in this paper are as follows:

- Spent fuel management concerning the policy in Japan and cost estimation of each storage system in case of 3,000 MTU BWR are shown;
- Process of introducing burn-up credit to cask storage system is shown;
- Some results of a long-term sealing test of a cask, using metallic gaskets for about eight years, preliminary thermal resistance tests concerning a concrete cask storage system conducted to clarify the long-term durability of it, etc., are shown.

Introduction

Spent fuel discharged from a nuclear power station in Japan is to be stored until it is reprocessed. Actually, half of the spent fuel has already been sent to a reprocessing plant overseas and in Tokai. The amount of interim storage requirement, however, is increasing because the schedule of future reprocessing planning is suspended, as shown in Figure 1.

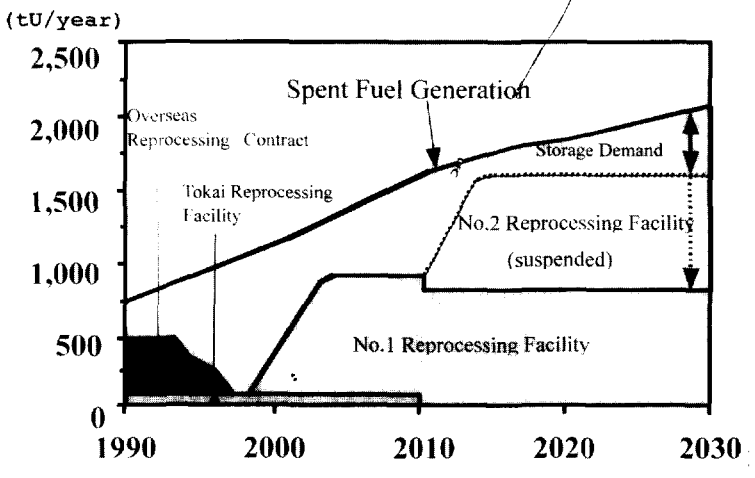

Figure 1. Spent fuel management in Japan

Current Status and Policy of Spent Fuel Storage

In June 1995, the Ministry of International Trade and Industry of the Japanese government, recognizing that spent fuel includes valuable resources such as plutonium and is, so to speak, "fuel resources to be recycled," indicated mainly the following policy.

Current Status Concerning Fuel Resources to Be Recycled

In Japan, since 1996, 12,940 tons of uranium fuel has been used for nuclear power generation. Among them, 6,550 tons of uranium has been reprocessed in and outside the country. The rest of the uranium fuel has been stored in pools or metal casks at reactors. Spent fuel is now being generated at approximately 900 tU/year, which exceeds the reprocessing capacity of 800 tU/year in Japan.

Necessity of Interim Storage of Fuel Resources to Be Recycled

In addition to the conventional spent fuel storage at reactors, it is necessary to make it possible to use interim spent fuel storage facilities away from reactors before 2010. The required storage capacity may be 6,000 tU in 2010 and 15,000 tU in 2020, by way of trial calculation.

Research and development works for the high burn-up and MOX spent fuels that will be the main object in this next stage of storage strategy have been performed in CRIEPI for five years. This paper outlines the results of those R&D works, together with some future R&D plans in CRIEPI.

Result

Cost Estimation of Storage System

A general design study and cost estimation for some storage systems was performed in the case of handling the high burn-up and MOX spent fuels that have increased rates of radiation dose and heat generation.

Figure 2 gives the results of the cost estimation for the storage of 3,000 MTU BWR high burn-up spent fuel. Concrete module-type storage systems such as concrete silos and concrete casks showed the better economics.

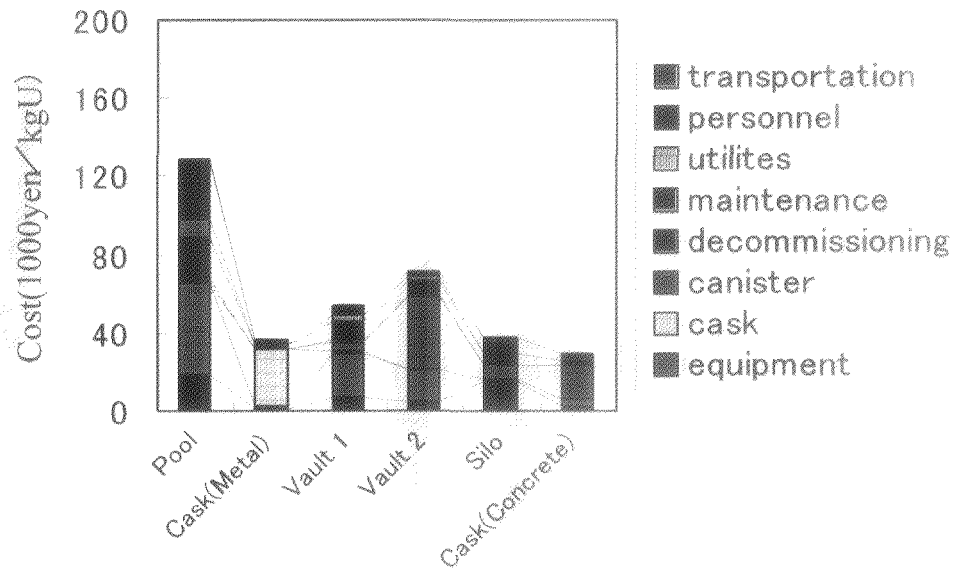

Figure 2. Cost estimation — 3,000 MTU BWR

Introduction of Burn-up Credit

Criticality design of the conventional storage facilities and flask is based on the fissile enrichment value of the newly fabricated fuel, which contributes to the overestimation of the system.

Storage density of spent fuel is calculated to be increased by 20 percent to 30 percent by the introduction of burn-up credit through the estimation of the decreased amount of fissile materials of spent fuel. Three methods of introducing the burn-up credit are proposed, depending on the procedure used for the estimation of burn-up value or reactivity. Those are the method of using the burn-up measurement of spent fuel, the method of using the data of core and fuel ID management and the method of reactivity measurement of flask (Figure 3).

Destructive analysis of the fissile elements in the high burn-up and MOX spent fuels was also carried out to check the computer code of the burn-up calculation.

Sealing

A sealing test of the metallic gasket has been performed for about eight years and is still under operation with a full-scale lid model of the storage cask. Very low permeability has been obtained until now, as is shown in Figure 4.

Preliminary Thermal Resistance Test

It is necessary to evaluate the thermal resistance property of the concrete if spent fuels are stored in a concrete module-type facility. Thermal tests using cylindrical concrete were conducted to investigate the thermal resistance properties of a specimen (crack generation, etc.).

Test equipment consists of an air-circular-type hood with constant temperature and humidity and electric heaters to make the inner surface of the concrete specimen hot.

The main specifications of the hood are as follows:

Dimensions: 1,500 mm × 1,500 mm × 1,500 mm
Humidity: 60 percent (relative humidity in a temperature range from 50°C to 80°C)

The main specifications of the electric heaters are as follows:

Temperature: 80°C–200°C
Heat generation: 20 kW (4 kW × 5 circuits)

Characteristics of Test Specimens

The cylindrically shaped test specimen consists of a reinforced concrete and a carbon steel liner plate with 9.5 mm thickness at the inner surface of it.

The dimensions of the test specimen are as follows:

Outside diameter: 1,200 mm
Inside diameter: 600 mm
Height: 1,000 mm

The layout of reinforcements in the test specimen is shown in Figure 5. A schematic view of the test specimen is shown in Figure 6.

Measurements

T-type thermocouples are utilized to measure the ambient temperature and each part of the test specimen. Two types of the strain gauges (mold and wire-type) are utilized to measure the strains of each part of the test specimens.

Test Conditions

Test conditions were selected in accordance with the maximum temperature limit specified by the regulations under the normal storage condition in the United States.

Initial: 24°C (the hood and the specimen)
Hood: 24°C (constant)
Inner surface of the concrete specimen: 65°C
Temperature rise rate: 1°C/hour (at inner surface of the specimen)

Thermal Test Results

Crack generations were confirmed by the measured strain data during the test and the visual observation after the thermal test. The observed cracks of the concrete specimen are shown in Figure 7 and Figure 8. The tensile stress at the crack generation part of the concrete specimen was confirmed to be nearly equal to the tensile strength of the concrete specimen.

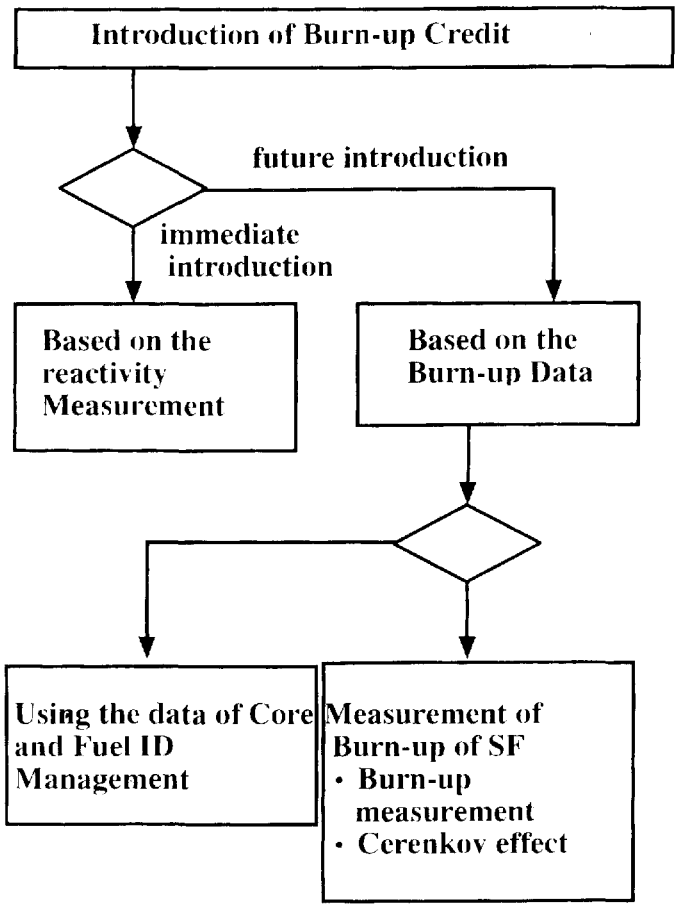

Figure 3. Process of introducing burn-up credit

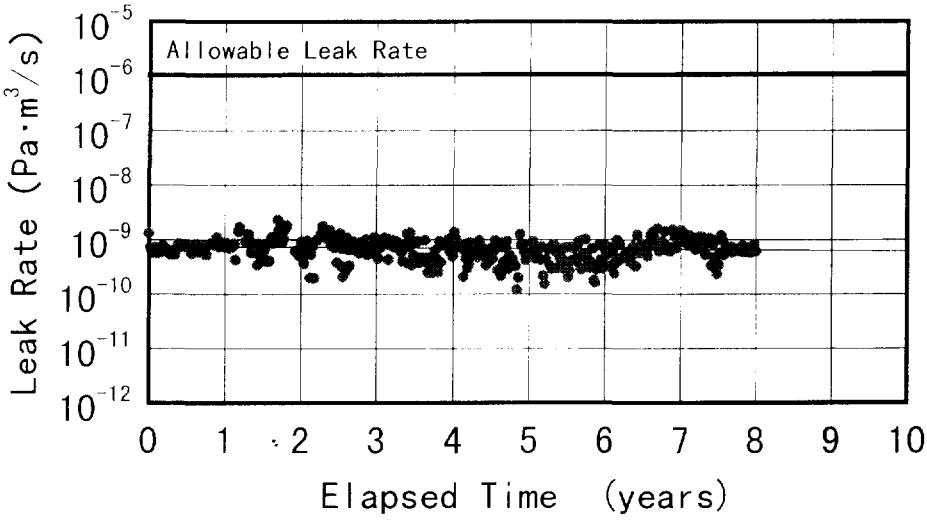

Figure 4. Long-term sealing test of cask

Future Plan

Concrete Module Storage System

Concrete module-type storage systems appeared to have better economics through those R&D works in CRIEPI, but the permission of the Japanese authorities has not been received, so all the data are not available now.

The following research is planned to propose the safety assessment procedure for the concrete module-type storage methods.

(1) Long-term durability, thermal resistance and structural reliability of the concrete cask and structural materials;
(2) Corrosion resistance of the welded part of the canister;
(3) Long-term performance of the nuclear fuel cladding.

New Area of Spent Fuel Storage Technology

Utilization of Heat and Radiation of Spent Fuel

A system for using the heat generated from spent fuel was designed and evaluated. Effective use of the heat is obtained by the introduction of a heat-pump system to elevate the temperature of the water coming out through the heat exchanger in Figure 9.

Radiation could be used for up to 1,000 Gy/h by installing the proper radiation-exposure apparatus inside the spent fuel storage facility.

Utilization of Depleted Uranium and Decommissioning Waste

Depleted uranium and metallic waste generated by the decommissioning of nuclear power stations are to be evaluated for their use as the structural materials or the radiation-shielding materials of the storage cask.

Conclusion

Spent fuel storage is inevitable for the flexible management of nuclear fuel cycle and will have a very important role where the requirement of interim storage is expected to increase as the schedule of future reprocessing in Japan will supposedly delay. CRIEPI has contributed a lot for the establishment of the safety assessment of the iron cask storage system in Japan and is going to continue its research activity in this field for the future demand of large-scale and longer-period spent fuel storage in Japan.

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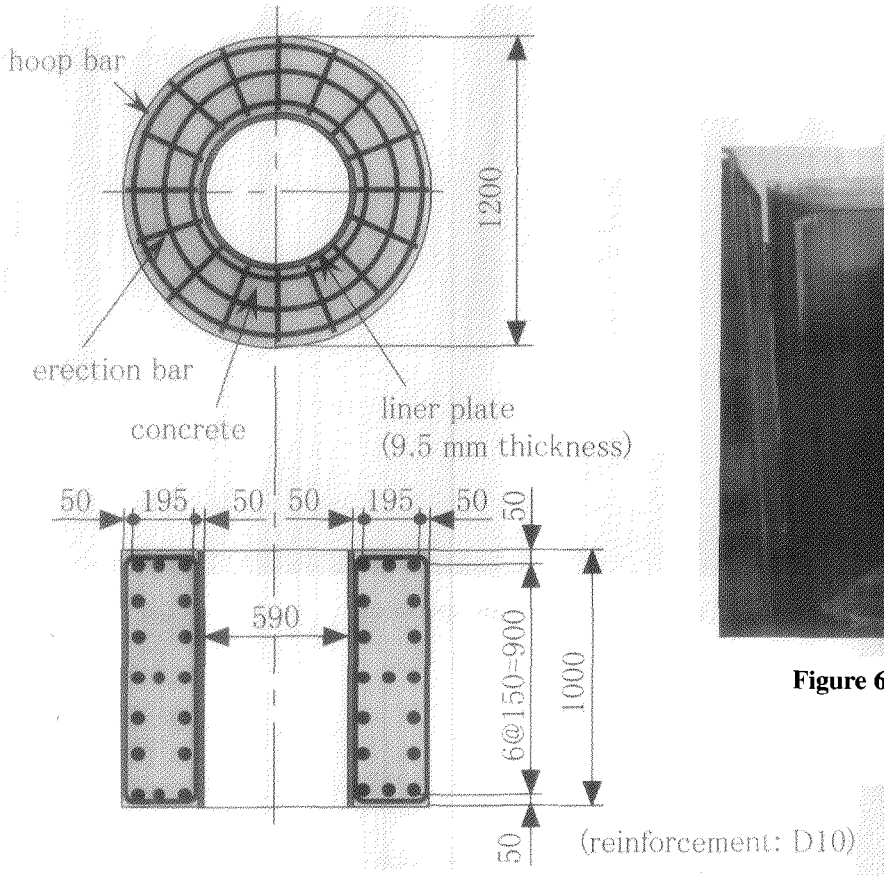

Figure 5. Layout of reinforcements in the concrete specimen

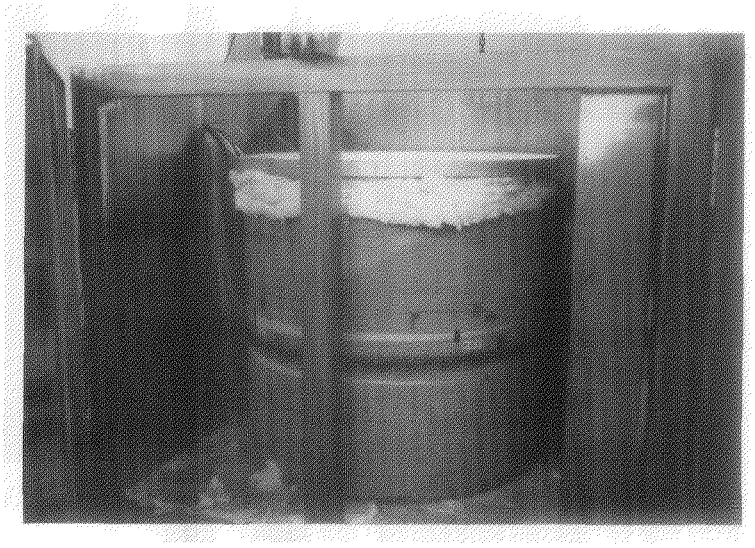

Figure 6. Schematic view of the concrete specimen

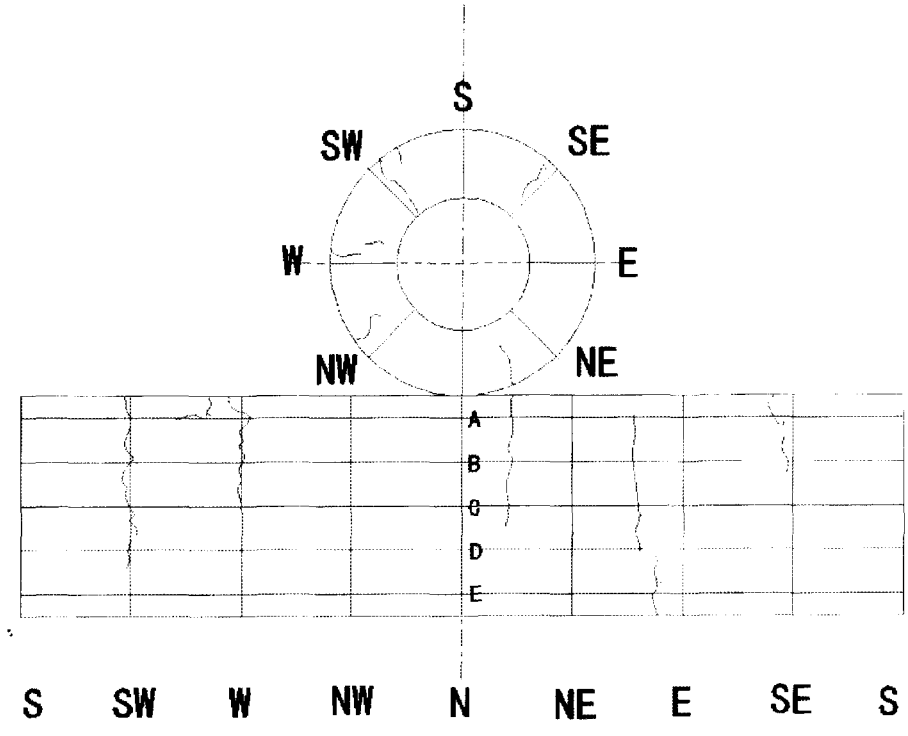

Figure 7. Cracks of the concrete specimen (extend elevation)

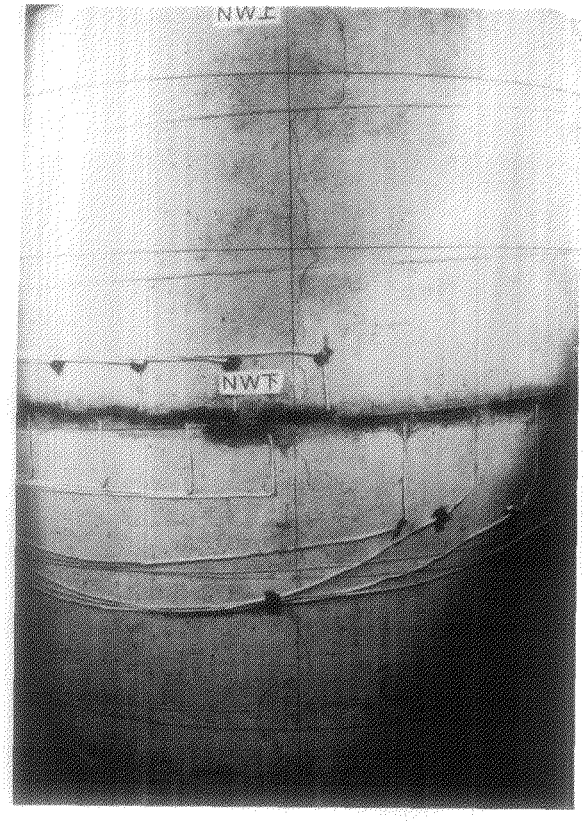

Figure 8. Cracks of the concrete specimen

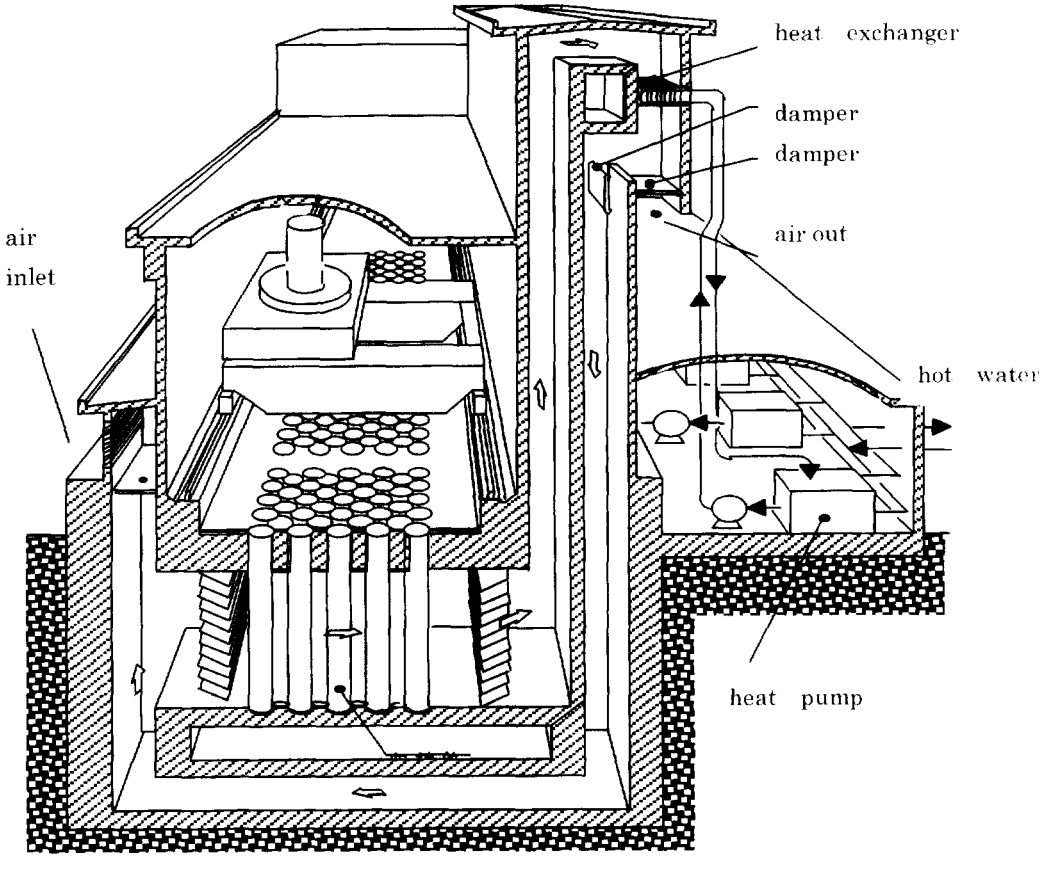

Figure 9. Vault-type storage facility equipped with heat-removal system

Multilateral Nonproliferation Cooperation:

U.S.-led Effort to Remove HEU/LEU Fresh and Spent Fuel from the Republic of Georgia to Dounreay, Scotland (Auburn Endeavor/Project Olympus)

■

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■

In early March 1998, the United States government approved a plan in cooperation with the United Kingdom and Georgian governments to rapidly retrieve and transport about 4.3 kilograms of enriched uranium. This material consisted largely of highly enriched uranium and a small amount of low-enriched uranium fresh fuel, as well as about 800 grams of HEU/LEU-based spent fuel from a shutdown IRT-M research reactor on the outskirts of Tbilisi in Georgia, a former Soviet republic. A technical team led by DOE consisted of HEU handling, packing and transportation experts from the Oak Ridge Y-12 Plant, managed and operated by Lockheed Martin Energy Systems, and spent fuel handling and transportation experts from NAC International in Norcross, Georgia, U.S.A. The team was part of an interagency task force formed with Department of Defense military personnel under U.S. European Command and headed by a senior official from the Department of State. The operation was executed in full cooperation with the government of the Republic of Georgia and the staff at the Institute of Physics. In April of 1998, the fresh fuel was repacked in U.S.-supplied 6M-2R containers [USA/0002/B(U)F] and the spent fuel was repacked in the NAC-LWT cask [USA/9225/B(U)F-85]. All the containers were then transported in one U.S. Air Force C-5B cargo aircraft via air-to-air refueling from Tbilisi, Georgia, to Kinloss Royal Air Force Base outside Inverness, Scotland. In Scotland the fresh and spent fuel was transported north to the Dounreay Nuclear Complex west of Thurso, Caithness, Scotland, for interim storage and final disposition. This successful national security project was the first time the United States teamed with a NATO partner to remove nuclear material from a site of proliferation concern.

The nuclear research reactor IRT-2000 of the Georgian Academy of Sciences' Institute of Physics achieved initial criticality in 1959 and remained operational until 1988. The IRT-2000 is a research and test reactor that was designed in the Soviet Union and has a thermal power of 2,000 kilowatts. The reactor designation was changed to IRT-M in 1968 following "modernization" of the facility, including an upgrading of the thermal power to 8,000 kW. This reactor belongs to the group of light water pool-type reactors in which ordinary water (light, distilled) is used as heat carrier and moderator of neutrons and biological protection as well. A number of different fuel types were involved in the repacking operations. (See Tables I and II.)

The National Security Council, answering to the Executive Branch, directed the United States' effort. The departments of State, Defense and Energy were directed to execute the mission. The State Department negotiated all agreements and managed

Table I. Fresh fuel elements

Fuel Assembly	Enrichment ^{235}U wt%	Quantity of ^{235}U per element
EK-10	10	8 grams
IVV-2	90	4.2 grams
TTR	90	4.5 grams
IRT-2M	90	24 grams

Table II. Spent fuel elements

Fuel Assembly	Enrichment ^{235}U wt%	Quantity of ^{235}U per assembly
IRT-1000	10	128 grams
IRT-2M	90	170 grams
TTR	90	410 grams

the policy issues in the Republic of Georgia and in the U.K. The Defense Department, through the European Command, was responsible for logistics, transportation and coordinating security with Georgia. The Energy Department was responsible for the repacking action and interface with the Georgian Institute of Physics and the U.K. Nuclear Industries Directorate and Directorate of Civil Nuclear Security.

The Office of Nonproliferation and National Security within the Department of Energy directed the repacking effort with support from the Oak Ridge and Oakland Operations. Oakland Operations provided the senior field manager and the Oak Ridge Operations and contractors provided the technical expertise. The technical experts were from the Y-12 Plant and the Oak Ridge National Laboratory. The spent fuel operations were conducted by technical experts from NAC International under contract with the Y-12 Plant.

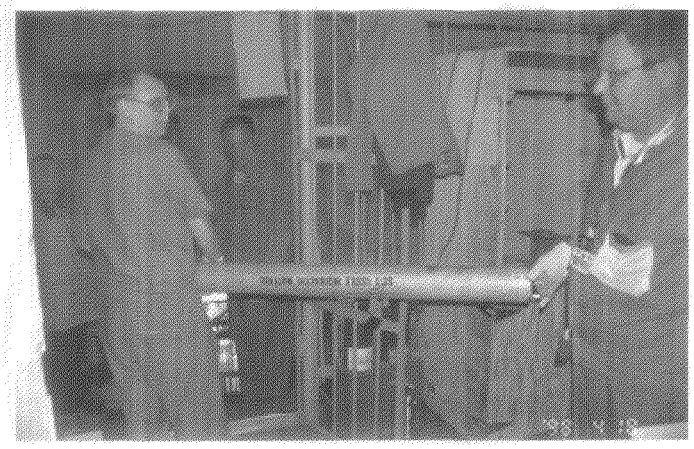
As a result of the requirements imposed upon the transport of spent nuclear fuel, as well as conditions at the nuclear facilities in Tbilisi and Dounreay, NAC International undertook several project-specific activities to prepare for the upcoming shipment. These activities included a technical evaluation of the proposed spent fuel to be transported as related to the NAC-LWT cask and the design and fabrication of some special shielded handling equipment.

Evaluations and analyses were performed in support of the preparation of a safety analysis report amendment specifically for this shipment. Because NAC International typically performs all engineering evaluations and analyses in support of their transportation activities, all of this work was performed in-house in a very confidential manner. The evaluations and analyses included individual fuel assembly and total payload structural evaluations, thermal (decay heat load) evaluation, a containment analysis (releasable radionuclide inventory), a neutron and gamma source term evaluation and the criticality (reactivity) evaluations. These assessments were performed for both the normal conditions of transport as well as for the accident case, and demonstrated that the special spent fuel assemblies identified in Table II were fully bounded by the existing licensed payload for the NAC-LWT. Once complete, this amendment, along with the fresh fuel description, was transmitted to the U.S. Department of Energy for approval and then to the Republic of Georgia and the United Kingdom for concurrence and validation.

For more than 10 years NAC International has designed, fabricated, tested and operated a variety of dry transfer systems to transfer spent nuclear fuel from facilities with limited crane capabilities or limiting accesses and features to IAEA- and U.S. NRC-licensed spent fuel transport casks. These dry transfer systems have been operated in diverse environments in the United States and throughout the world, including facilities located in Iraq and Colombia. Over the years, NAC has successfully and safely transferred well in excess of 3,000 fuel assemblies using their dry transfer system equipment. Based upon information obtained from a variety of independent sources, it was determined that additional equipment would be needed to supplement NAC's versatile dry transfer system at the IRT-M reactor facility in the Republic of Georgia. This supplemental equipment was designed and fabricated to facilitate cask-loading operations in Tbilisi while utilizing NAC's dry transfer system equipment and the NAC-LWT cask. Following fabrication but before mobilization overseas, the equipment was tested in the United States to ensure proper operation with the cask and all the existing equipment.

The mission was planned in cooperation with the USEUCOM, the government of the Republic of Georgia and the U.K. govern-

Equipment needed for the fuel transfer is loaded onto one of two U.S. Air Force C-5B Galaxy cargo planes used during the operation.



Scientists at the Georgian Academy of Science's Institute of Physics work with U.S. specialists to complete an inventory of the fresh fuel elements and begin the repacking operations.

ment. The basic mission plan required the United States to stage the various fresh and spent fuel equipment in Oak Ridge; debark from the McGhee-Tyson Air National Guard base near Knoxville, Tenn.; refuel and collect additional assets in Germany; and embark at the Tbilisi airport. The equipment and team were transported by two U.S. Air Force C-5B Galaxy cargo planes.

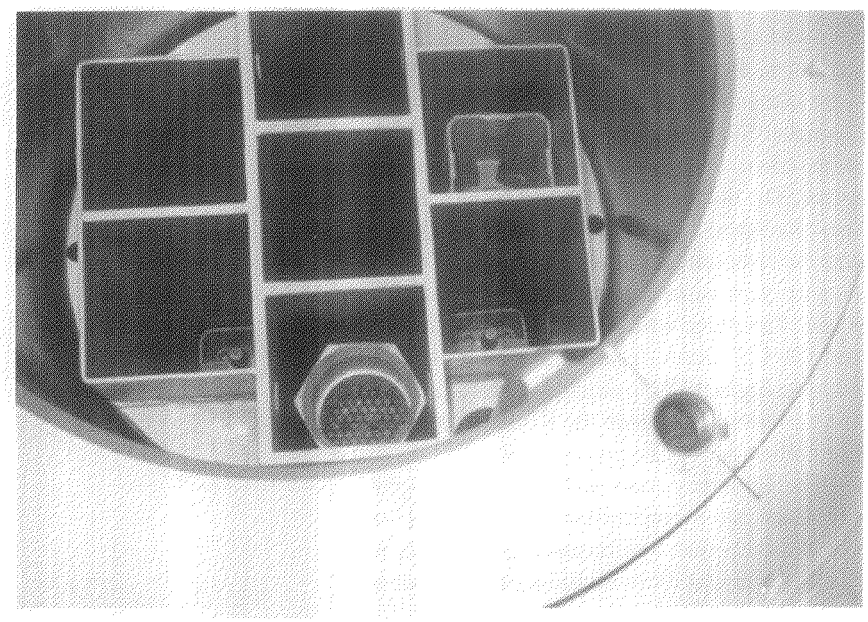
Air transport was chosen because there were no reliable land or rail routes through western Georgia. The bulk of the equipment was tied down to three long-bed trailers and tractors supplied by the United States. Additional tractors and trailers in Georgia were contracted to transport the balance of the equipment from the airfield to the reactor and for the subsequent return trip. A 70-ton crane was contracted from Georgian industries and set up at the reactor site. The Georgian government provided overall safety and security while the team was deployed and the weapons-grade material was being moved.

On arrival at the reactor, the U.S. team and Georgian scientists distributed the equipment to their respective areas of operations. The fresh fuel operations were concentrated near the vault located in the top floor of the reactor, where the fresh fuel packages were secured. Once the vault was opened, the vault, packages and fuel elements were surveyed to baseline the level of radioactive contamination, which was found to be very low. The reactor scientists and the U.S. specialists completed an inventory of the fuel elements and initiated the repacking operations.

Each fuel element type was divided into lots that were limited to no more than 350 grams of ^{235}U. This was determined to be the safest accumulation of HEU consistent with the nuclear safety standards and the transportation requirements. Each lot of rods was weighed and accounted for. The lot was subjected to a nondestructive analysis using a high-purity germanium detector to determine the enrichment and mass of the ^{235}U. The mass was compared to that declared to provide the United States and United Kingdom sufficient proof of the amount of fissile material being transferred from Georgia to the United Kingdom. The lots were loaded into cans that were loaded and sealed in the U.S. Department of Transportation 6M-2R package under the international authorization USA/0002/X. A total of 16 packages were loaded with the fresh fuel rods and elements. The fresh fuel repacking operation required five days to set up, walk through, repack and tear down.

Meanwhile, the spent fuel operations were being conducted in parallel. These activities took place primarily just outside the reactor building and inside the reactor hall. Following receipt of the equipment at the site, the shipping cask was prepared for loading by setting up and leveling the base plate, then up-ending the casket and placing it upon the base plate. The shipping cask adapter was then installed on top of the cask. Next, the transfer cask and fuel canister grapple were set up for proper operation, along with the facility transfer shield that would be loaded with spent fuel in the reactor building. Once the equipment was prepared, a dry run was performed to verify proper system operability prior to handling the highly irradiated fuel.

After authorization to proceed was given, an empty canister was placed in the facility transfer shield and the assembly was lowered into the spent fuel pool inside the reactor building. The spent fuel elements were then loaded into the canister and the transfer shield was removed from the pool and allowed to drain. The shield containing the spent fuel was then transferred outside to an area near the transfer cask and NAC-LWT.



Spent fuel awaiting removal at the Tbilisi, Georgia, IRT-M reactor.

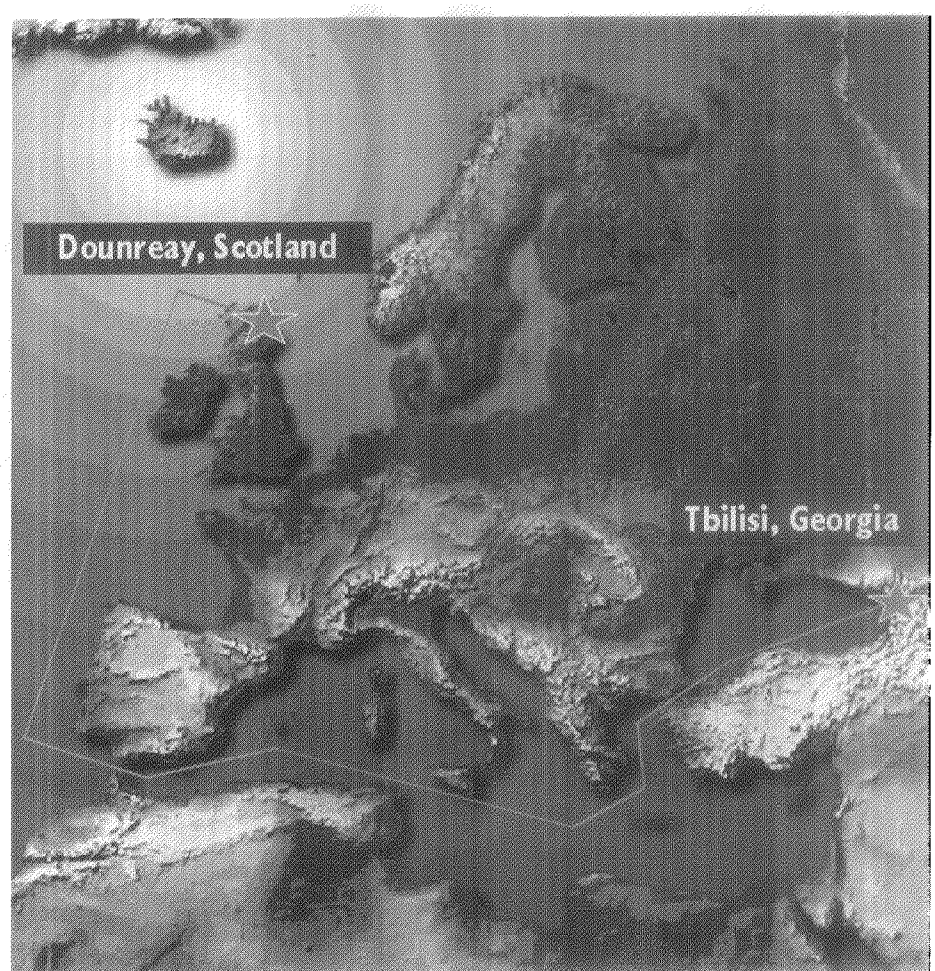
The transfer cask was used to remotely extract the canisters of spent fuel from the shield and then lower the canister into the NAC-LWT. All spent fuel operations were performed remotely using shielded equipment to minimize any radiation exposure to people in the vicinity of the operations. After the cask was loaded with fuel, shipment preparations were completed and all support equipment was packaged for transport. All operations associated with preparing the spent fuel for transport were safely completed, without incident, in only four days.

The facility transfer shield, loaded with spent fuel, is transferred out of the reactor building for loading in the transfer cask and NAC-LWT.

On completion of the repacking operations, all equipment, work areas and packages were checked for surface contamination, which was found to be below allowable or nonexistent. The gear was repackaged and readied for the transport to the airport. The fresh and spent fuel packages, the support equipment and the team were taken to the airport in a direct route under Georgian Security Forces protection. Personnel were taken to the airport hours later under escort. The nuclear weapons-grade material and spent fuel were loaded onto on C-5B cargo plane, and the remaining equipment and USEUCOM logistic gear were loaded onto the remaining plane. The plane with the fresh and spent fuel and the U.S. team departed from Tbilisi on a nonstop flight path requiring two in-flight refueling operations to reach the Kinloss Royal Air Force Base east of Inverness, Scotland.

The Dounreay team and the Scottish security force were responsible for the cargo of nuclear fuels that was transported by truck to the Dounreay facilities on the northern coast of Scotland, near Thurso.

Following the initial survey of the transport packages, the fresh fuel was removed from its packages and placed into temporary storage within a few days on arrival at the plant. The transfer of the spent fuel was delayed for three weeks, subject to authorization from the Nuclear Inspectorate's Office and final authorization by the prime minister. Once authorization was received, transfer of the spent fuel proceeded expeditiously and was completed in two days.



The plane with the fresh and spent fuel and the U.S. team departed from Tbilisi for Kinloss Royal Air Force Base in Scotland on a nonstop flight path requiring two in-flight refueling operations.

Disclaimer

Continuing Battle on the Acceptance of Spent Fuel: Is There an Appropriate Remedy?

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The following is the outline of a presentation delivered by the author at the INMM Spent Fuel Management Seminar XVI.

I. Introduction

A. Almost one year since DOE defaulted on their obligation to accept spent fuel
B. Nuclear Waste Policy Act obligation
   1. Section 302(a)(5)(B): "In return for the payment of fees established by this section, the Secretary, beginning not later than January 31, 1998, will dispose of the high-level radioactive waste or spent fuel involved as provided in this subtitle."

II. *Indiana Michigan Power v. DOE*

A. Requested relief (Petition for Review, May 30, 1995) (original petition, filed June 20, 1994 in *Northern States Power v. DOE*, dismissed as not ripe, July 28, 1995)
   1. Declaration that 1998 is an unconditional obligation.
   2. Order directing DOE to develop program to meet 1998 deadline and provide six-month updates on meeting the deadline.
   3. "If warranted, at an appropriate stage of these proceedings, appropriate relief to alleviate all or a portion of Petitioners' financial burden [which relief] could include, but is not limited to an order allowing Petitioners to make payment of fees into an escrow or similar account rather than directly into the Nuclear Waste Fund."
B. Relief granted
   1. Declaratory judgment that DOE has an unconditional obligation "reciprocal to the utilities' obligation to pay, to start disposing of the [spent nuclear fuel] no later than January 31, 1998." 88 F.3d at 1277
   2. Remand to DOE "for further proceedings consistent with this opinion." *Id.*
C. Relief deferred
   1. "It is premature to determine the appropriate remedy, particularly as to the interaction between Article XI and Article XVI of the Standard Contracts, as DOE has not yet defaulted upon either its statutory or contractual obligation." *Id.*

III. *Northern States Power v. DOE*

A. Requested relief (Petition for Review, Jan. 31, 1997)
   1. Declaration that utilities are relieved of their Nuclear Waste Fund obligation and are authorized to place fees in escrow "unless and until DOE commences disposing of their SNF pursuant to its obligations under the NWPA."
   2. Prohibition against DOE taking adverse action against utilities suspending payments.
   3. Order directing DOE to develop and submit to the court a program to meet the 1998 deadline and provide six-month updates.
B. Requested relief (Petition for Mandamus, May 7, 1997)
   1. Order directing DOE to dispose of SNF beginning not later than Jan. 31, 1998, or alternatively to develop and submit to the court a program for DOE to meet the 1998 deadline.
   2. Declaration that utilities are relieved of their Nuclear Waste Fee obligation and are authorized to place fees into escrow "unless and until DOE commences disposing of their SNF pursuant to its obligations under the NWPA."
   3. Prohibition against DOE taking adverse action against utilities suspending payments
C. D.C. Circuit decision, 128 F.3d 754 (D.C. Cir. 1997)
   1. Reaffirmed unconditional obligation in NWPA. "We held in *Indiana Michigan* that the NWPA imposes an unconditional duty on DOE to take the materials by 1998. Congress, in other words, directed DOE to assume an unqualified obligation to take the materials by the statutory deadline." 128 F.3d at 760.
   2. Explicitly extended obligation to Standard Contract. "The contractual obligations created consistently with

the statutory contemplation leave no room for DOE to argue that it does not have a clear duty to take the SNF from the owners and generators by the deadline imposed by Congress." 128 F.3d at 758–9.

3. Indicated dissatisfaction with DOE response to *Indiana Michigan*
   "After issuing our decision in *Indiana Michigan*, we would have expected that the Department would proceed as if it had just been told that it had an unconditional obligation to take the nuclear materials by the January 31, 1998, deadline. Not so. Quite the contrary ..." 128 F.3d at 757.
4. Applied mandamus tests
   a. Clear right to relief — "Petitioners' full compliance with the requirements of the NWPA, taken in conjunction with DOE's refusal to perform its reciprocal duties, compels the conclusion that petitioners have established a clear right to relief in this case." 128 F.3d. at 758.
   b. Clear duty to act — "DOE's duty to act could hardly be more clear." 128 F.3d at 758.
   c. No other adequate remedy — The Standard Contract presents "another potentially adequate remedy." 128 F.3d at 759.
   d. Since petitioners "have not convinced us that this contractual scheme is inadequate," the Court declined to issue "the broad writ of mandamus sought by petitioners." 128 F.3d at 759.
5. The "potentially adequate remedy"
   a. Court recognizes possible "billions of dollars in additional costs" from DOE's failure. 128 F.3d at 759.
   b. Suggests contractual processes should take these costs into account "if the contractual processes operate as Congress intended." 128 F.3d at 759.
   c. Focus on Article IX, Delays Clause, with parenthetical mention of Article XVI, Disputes Clause.
   d. Article XI, Remedies, not mentioned.
   e. Decision uses "damages," "additional expenses," "costs caused by [DOE's] delay" interchangeably.
   f. "[P]etitioners must pursue the remedies provided in the Standard Contract in the event that DOE does not perform its duty to dispose of the SNF by the January 31, 1998, deadline." 128 F.3d at 759.
6. Rejection of "unavoidability" defense
   a. Inconsistent with unconditional obligation
      "DOE's position is that its delayed performance is unavoidable because it does not have an operational repository and does not have authority to provide storage in the interim. DOE is simply recycling the arguments rejected by this Court in *Indiana Michigan*." 128 F.3d at 760.
   b. Invalidates DOE's interpretation of "unavoidable delays" clause because it would "absolve itself from bearing the costs of its delay if the delay is caused by the government's own acts." 128 F.3d at 760, and precludes DOE from interpreting Standard Contract to allow unavoidability defense.
   c. Grants in part petition for writ of mandamus to correct DOE's approach toward contractual remedies.
7. Court retains jurisdiction "pending compliance with the mandate issued herewith." 128 F.3d at 761.

D. DOE's initial reaction
   1. "99.9% victory"
   2. But considering rehearing
   3. Interest in mitigation possibilities — Private Fuel Storage LLC
   4. Acknowledges damages possibilities
      a. But damages to be paid from Nuclear Waste Fund

E. DOE Rehearing Petition (Dec. 29, 1997)
   1. Petition for rehearing and suggestion for rehearing *en banc*
   2. Jurisdictional arguments
      a. DOE reads *NSP* decision as D.C. Circuit asserting jurisdiction over government contract disputes
      b. Interprets decision as making *force majeure* clause (Article IX of the Standard Contract) inapplicable to disputes over DOE's delays
      c. Allegedly inconsistent with Tucker Act, 28 U.S.C.1491
   3. DOE's gratuitous comments
      a. "[F]ew contract holders seem likely initially to receive significant equitable adjustments of their fees."
      b. "[A]ny substantial downward adjustments in the fees paid by some contract holders in later years may well force offsetting adjustments."

F. Yankee Atomic Rehearing Petition (Dec. 29, 1997)
   1. Only addressed to *NSP* panel, not *en banc*
   2. "Another potentially adequate remedy" not adequate for Yankee
      a. Only removing spent fuel will allow completion of decommissioning
      b. Money damages not adequate
   3. Argument that Yankee is unique among all other utility petitioners
      a. Permanently shutdown
      b. Very near goal of complete decommissioning
      c. All Nuclear Waste Fees paid
   4. D.C. Circuit Order (Jan. 7, 1998) ordering DOE to respond to Yankee petition by Jan. 22, 1998

IV. Post-*NSP* Developments Before Damage Claims Filed

A. NSP CEO letter to Secretary Peña (Nov. 21, 1997)
   1. Reminds DOE of concession by DOE attorney at *NSP* oral argument that DOE could physically begin to take spent fuel by Jan. 31, 1998.

2. Expects that DOE will meet its unconditional obligation and asks DOE to promptly confirm that it will do so

B. DOE response (Dec. 30, 1997)
   1. From acting general counsel
   2. DOE "regrettably is not able to provide the confirmation you request"
   3. Court did not grant the utilities' requested order to move fuel "and the Department does not anticipate that it will be able to begin disposal by the statutory date"

C. Utility Petition to Suspend Fee Payments (Dec. 11, 1997)
   1. ConEd and 28 other utilities petition to DOE Contracting Officer
   2. Consistent with *NSP* decision directing utilities to exercise Standard Contract remedies and based on reciprocal obligations of utilities to pay Nuclear Waste Fees and of DOE to begin to dispose by Jan. 31, 1998
   3. Sought determination that utilities not obligated to make payments into the Nuclear Waste Fund unless and until DOE complies with its reciprocal obligation
   4. Distinguished petition from damages claims

D. Contracting Officer's response (Jan. 12, 1998)
   1. Cites to *NSP* decision declining to grant escrow relief to utilities
   2. Determines that utilities' obligation to pay "continues notwithstanding the Department's delay, subject to the outcome of individual requests for equitable adjustment of the charges pursuant to Article IX.B of the standard contract."
   3. Repeats prior "invitation" by DOE to "consider[] amendments to particular contracts to address the hardships the Department's anticipated delay may cause individual contract holders."

V. Spent Fuel Damages Lawsuits

A. Ten lawsuits to seek damages in U.S. Court of Federal Claims
   1. First four cases filed on behalf of shutdown nuclear plants
      a. Lawsuits allege partial breach of contract and related claims (breach of implied covenant of good faith and fair dealings, illegal exaction of spent fuel storage costs)
      b. Yankee Atomic (Feb. 18, 1998) — asked for more than $90 million
      c. Connecticut Yankee (March 4, 1998) — asked for more than $90 million
      d. Maine Yankee (June 2, 1998) — asked for more than $128 million
      e. Somewhat different approach filed by Sacramento Municipal Utility District on June 9, 1998
   2. First damages cases filed on behalf of operating nuclear plants filed on June 8, 1998
      a. Northern States Power — asked for more than $1 billion
      b. Duke Power — asked for more than $1 billion
      c. Florida Power & Light — asked for more than $300 million
      d. Indiana Michigan Power — asked for more than $150 million
   3. Other cases on behalf of operating nuclear plants
      a. Southern Nuclear, Alabama Power and Georgia Power (July 29, 1998) — asked for more than $1.5 billion
      b. Commonwealth Edison (July 30, 1998) — asked for an unspecified amount of damages

B. An eleventh lawsuit seeking damages was filed in the U.S. Court of Appeals for the D.C. Circuit. Filed by Consolidated Edison Co. of New York and three other utilities on July 30, 1998.
   1. ConEd argues that the NWPA gives the Court of Appeals "original and exclusive jurisdiction" to hearing all claims — including damage claims — involving the NWPA. Jurisdictional issue will be decided by the Court of Appeals over the next several months.

C. DOE filed motions to dismiss the *Yankee, Connecticut Yankee, Maine Yankee* and *Northern States* lawsuits
   1. Argued that utilities were required by Standard Contracts to present claims for damages to the DOE Contracting Officer and then to the DOE Board of Contract Appeals before proceeding to the Court of Federal Claims.
   2. Utilities have argued that the breach of contract claims filed properly

D. Utilities also filed motions for summary judgment, arguing that they were entitled to a ruling the DOE had breached its contractual obligation and was therefore liable for damages (which will be determined at trial).

E. Judge heard *Yankee* case on Oct. 24, 1998
   1. Denied the DOE's motion to dismiss on all but the "illegal exaction" claim and granting Yankee's motion for summary judgment on DOE's contract liability

F. Similar opinions issued in *Connecticut Yankee* (Oct. 30, 1998) and *Maine Yankee* (Nov. 3, 1998) cases
   1. *Maine Yankee* opinion rejected the government's argument that because DOE's schedule did not call for Maine Yankee to deliver any spent fuel to DOE until 1999, the lawsuit was premature

G. Similar motion to dismiss and motion for summary judgment have been filed in *Northern States* case (which is being treated as the lead case for the *Duke, FP&L* and *Indiana Michigan* cases). Oral argument has not been scheduled for these motions.

H. *Yankee, Connecticut Yankee* and *Maine Yankee* now in pretrial phase with arguments between DOE and the utilities on whether and when type of discovery should occur

Chapters

continued from page 6

- A meeting between INMM President D. Dickman and the presidents of the Russian and Obninsk chapters was held in November 1998 in Obninsk to settle organizational issues;
- Presentation of a series of lectures on nonproliferation problems for students of Moscow Physics Engineering Institute within the framework of cooperation with the U.S. Sandia National Laboratories (A. Izmailov, A. Roumiantsev, V. Shmelev, V. Orlov, etc.). Eight students successfully defended their master's theses in April;
- Participation of chapter members in meetings of the Moscow Carnegie Center related to nonproliferation issues;
- Preparation of presentations for the 40th INMM Annual Meeting in Phoenix, Ariz., U.S.A.

The chapter has no financial activities. Funding allocated by INMM is used for payment of membership fees.

Alexander Izmailov
President, INMM Russian Federation Chapter
Eleron (Minatom of Russia)
Moscow, Russia

Vienna

The Vienna Chapter held its Annual Safeguards Symposium March 11. The keynote speaker was Bruno Pellaud, head of the Department of Safeguards and deputy director general of the IAEA. Pellaud opened the symposium with a talk titled "Safeguards: The Road Ahead." Following his presentation, eight INMM members and other IAEA employees presented papers on a variety of safeguards topics. One paper, "Experiences with Environmental Swipe Sampling in a Newly Built Gas Centrifuge Enrichment Plant," was selected by the Department of Safeguards for presentation at the INMM Annual Meeting in July. Several members of the Vienna Chapter will present papers at the meeting in Phoenix.

In May, the Vienna Chapter held a quarterly luncheon meeting. Laercio Vinhas, adviser to the president of the Brazilian Nuclear Energy Commission, discussed the Brazilian Nuclear Programme and the challenges involved in implementing the additional protocol to safeguards agreements. This event was attended by a large number of luncheon guests, including Pierre Goldschmidt, the newly appointed deputy director general at the IAEA Department of Safeguards, and Paulo Barreto, director of technical cooperation for Europe, Latin America and West Asia, as well as several state representatives serving on SAGSI.

Jaime Vidaurre-Henry
President, INMM Vienna Chapter
International Atomic Energy Agency
Vienna, Austria

Author Submission Guidelines

The *Journal of Nuclear Materials Management* is the official journal of the Institute of Nuclear Materials Management. It is a peer-reviewed, multidisciplinary journal that publishes articles on new developments, innovations, and trends in safeguards and management of nuclear materials. Specific areas of interest include physical protection, material control and accounting, waste management, transportation, nuclear nonproliferation/international safeguards, and arms control and verification. *JNMM* also publishes book reviews, letters to the editor, and editorials.

Submission of Manuscripts: *JNMM* reviews papers for publication with the understanding that the work was not previously published and is not being reviewed for publication elsewhere. Papers may be of any length.

Papers should be submitted in *triplicate*, **including a copy on computer diskette**. All popular Macintosh and IBM word processing formats are acceptable. Submissions should be directed to:

Dennis Mangan
Technical Editor
Journal of Nuclear Materials Management
60 Revere Drive, Suite 500
Northbrook, IL 60062 USA

Papers are acknowledged upon receipt and are submitted promptly for review and evaluation. Generally, the author(s) is notified within 60 days of submission of the original paper whether the paper is accepted, rejected, or subject to revision.

Format: All papers must include:

- Author(s)' complete name and telephone number
- Name and address of the organization where the work was performed
- Abstract
- Camera-ready tables, figures, and photographs
- Numbered references in the following format:
  1. F.T. Jones and L.K. Chang. "Article Title," *Journal* 47(No. 2):112–118 (1980).
  2. F.T. Jones, *Title of Book*, New York: McMillan Publishing, 1976, pp. 112–118.
- Author(s) biography

Peer Review: Each paper is reviewed by two or more associate editors. Papers are evaluated according to their relevance and significance to nuclear materials safeguards, degree to which they advance knowledge, quality of presentation, soundness of methodology, and appropriateness of conclusions.

Author Review: Accepted manuscripts become the permanent property of INMM and may not be published elsewhere without permission from the managing editor. Authors are responsible for all statements made in their work.

Reprints: Reprints may be ordered at the request and expense of the author. Order forms are available from the Institute's office, 847/480-9573.

President Clinton Reappoints Three to Nuclear Waste Technical Review Board

President Bill Clinton has reappointed three members of the U.S. Nuclear Waste Technical Review Board for four-year terms. The 11-member board was created by Congress in the Nuclear Waste Policy Amendments Act of 1987 with a mandate to evaluate the validity of technical and scientific activities undertaken by the secretary of energy, including characterizing the Yucca Mountain site and packaging and transporting spent nuclear fuel and high-level radioactive waste.

John W. Arendt, who was first appointed to the board in 1995, is the founder of John W. Arendt Associates Inc., a consulting firm. Arendt is a registered professional engineer, a certified nuclear materials manager and a senior member of the Institute for Nuclear Materials Management. He holds a degree in chemical engineering and was a research engineer for the Manhattan Project at the University of Chicago from 1943. He worked for Union Carbide Corp.'s nuclear division from 1945 to 1984, holding various management positions.

Jeffrey J. Wong was first appointed to the board in 1995. Wong is chief of the Human and Ecological Risk Division of the Department of Toxic Substances Control at the California Environmental Protection Agency. He has more than 18 years of experience in toxicology and is an instructor in environmental toxicology at the University of California at Davis. Wong holds a doctorate in pharmacology and toxicology.

First appointed to the board in 1997, Alberto A. Sagüés is a professor of materials engineering in the Department of Engineering at the University of South Florida. Sagüés has special expertise in corrosion and materials engineering, physical metallurgy and scientific instrumentation. He is a registered professional engineer and he has a doctorate in metallurgy. He held several teaching positions in the United States and abroad before moving to the University of South Florida in 1985.

Information about the board and its members may be obtained from the board's Web site at http://www.nwtrb.gov. Requests for copies of reports or other information may be made by contacting the board at 703/235-4473; fax, 703/235-4495; e-mail, info@nwtrb.gov.

ESTECH 2000 Call for Papers

Papers are now being solicited for the 46th Annual Technical Meeting of the Institute of Environmental Sciences and Technology — ESTECH 2000 — to be held in Providence, R.I., April 30–May 4, 2000.

Papers must be current, technically sound, free of commercialism and not previously published. Abstracts of 300 words or less must be submitted to IEST by Sept. 15, 1999. Upon acceptance, a draft is required by Nov. 1, 1999, and a final revision must follow by Jan. 1, 2000. Papers will be published in the *IEST ESTECH 2000 Proceedings.*

For additional information about submitting abstracts, contact IEST at 847/255-1561; fax, 847/255-1699; e-mail, iest@iest.org; Web site, http://www.iest.org.

Richardson Selects Security 'Czar'

U.S. Secretary of Energy Bill Richardson named Gen. Eugene E. Habiger as the director of a new high-level Office of Security and Emergency Operations June 16. Habiger, who has been commander in chief in the U.S. Strategic Command, retired from the United States Air Force in 1998.

In this position, Habiger will be responsible for implementing Richardson's comprehensive security reform plan. He will oversee all security functions, including safeguards and security policy, cybersecurity, emergency operations functions and counterterrorism, which were previously handled by different DOE program offices. He reports directly to the secretary and began overseeing the reorganization in early July.

This appointment is the latest in Richardson's aggressive actions strengthening every aspect of security and counterintelligence at the Department of Energy during the last nine months. He has rebuilt the Department of Energy counterintelligence program, which will be among the most stringent in government by the end of this year, and has implemented more than 85 key reforms to counterintelligence, cybersecurity, physical security and oversight at the Department of Energy. The Office of Security and Emergency Operations is also part of Richardson's broader DOE reorganization plan, which includes improvements in field-headquarters reporting relationships and strengthens accountability of program line offices.

Habiger's role as security czar will extend his more than three decades of service in the United States. In his former position as commander in chief of the Strategic Command, Habiger was instrumental in the formulation and establishment of DOE's program for maintaining the nuclear deterrent without nuclear testing. In addition to being the commander in chief of the Strategic Command, he commanded two U.S. Air Force Bombardment Wings.

International Conference Highlights Use of Geological Formations for Radioactive Waste Disposal

Representatives of 12 countries were in Carlsbad June 14–17 for a conference about the behavior of radioactive materials in geological formations. The information presented could be used in developing safety criteria for radioactive waste disposal facilities throughout the world.

The GEOTRAP IV conference took place at the Pecos River Village Conference Center. The event was hosted by the U.S. Department of Energy's Carlsbad Area Office, the Organization of Economic Cooperation and Development/Nuclear Energy Agency and Sandia National

Laboratories. This was the fourth of five workshops, one held each year in a different country. Last year's workshop took place in Barcelona, Spain.

Approximately 50 representatives of government agencies, private industry and universities registered to attend the conference. With the Waste Isolation Pilot Plant as an example of successful deep geological nuclear waste disposal, participants learned specifically about the ability and inability of radioactive materials to move through certain geological formations. The conference included a full-scale tour of WIPP.

In addition to the United States, countries represented at the conference were Belgium, Canada, Finland, France, Germany, Japan, the Republic of South Korea, Spain, Sweden, Switzerland and the United Kingdom.

WIPP, a cornerstone of the DOE's cleanup effort, is designed to permanently dispose of defense-generated transuranic radioactive waste left from the research and production of nuclear weapons. The facility began disposal operations on March 26.

Westinghouse, WIPP Are First to Be Recertified Under Voluntary Protection Program

The Westinghouse Waste Isolation Division continued its history as one of the safest operating companies in the nation, becoming the first government contractor to receive recertification under the U.S. Department of Energy's Voluntary Protection Program.

Westinghouse, the management and operating contractor for the DOE's Carlsbad Area Office at the Waste Isolation Pilot Plant, received the honor after undergoing an in-depth evaluation by a six-member DOE headquarters VPP recertification team.

The Waste Isolation Division originally received "Star" status under VPP in October 1994. Westinghouse was the first federal contractor to be certified under VPP. In order to retain Star status, contractors are required to recertify under the program.

Patterned after a similar program sponsored by the Occupational Safety and Health Administration, the VPP was established by the DOE in 1993 to recognize superior performance in the field of safety and health by contractor management and their employees. Star status is the highest level that can be achieved under VPP guidelines.

The VPP recertification team was made up of representatives from organizations such as DOE, labor and other government contractors. Last summer, the team interviewed about 100 employees, asking about their roles in the WIPP's environment, safety and health programs.

Since the company began operating WIPP for the DOE in 1985, Westinghouse has been honored often for its positive approach to protecting employee safety and health. Awards and recognition include two awards of honor from the National Safety Council, a no-lost-time three million work hour record in 1992, and the state of New Mexico Inspector of Mines Operator of the Year award for 11 consecutive years.

Westinghouse employs about 630 people at WIPP, which began waste disposal operations in March.

IAEA Reviews Implementation of Safeguards in 1998

The Board of Governor's of the International Atomic Energy Agency, meeting in Vienna, Austria, June 7–11, reviewed the implementation of IAEA safeguards last year.

In 1998, the IAEA Secretariat concluded that the nuclear material and other items placed under safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for. This conclusion derives from the Secretariat's evaluation of the quantitative and qualitative results of implementing nuclear material verification activities at nuclear facilities and other locations in 68 states (and Taiwan, China). None of these verification activities gave any indication that declared and safeguarded nuclear material had been diverted for any military purpose or for purposes unknown, or that facilities, equipment or non-nuclear material placed under safeguards were being misused.

The agency, however, is still unable to verify the correctness and completeness of the initial declaration of nuclear material made by the Democratic People's Republic of Korea, and is therefore unable to conclude that there has been no diversion of nuclear material in the DPRK. The safeguards agreement between the DPRK and the agency remains binding and in force, and the agency is continuing to implement safeguards measures in the DPRK.

There was still no progress in technical discussions with the DPRK regarding the preservation by the DPRK of information that the agency deems necessary for verification of the correctness and completeness of the DPRK's initial declaration. Other issues remain unresolved, including monitoring liquid nuclear waste at the Radiochemical Laboratory (reprocessing plant) in the DPRK, and inspector access to technical support buildings at sites that are subject to the freeze. In addition, the DPRK has not permitted environmental sampling at its sites.

In 1998, the agency continued to make progress in the development and implementation of measures to strengthen the effectiveness and improve the efficiency of its safeguards system. Additional protocols concluded on the basis of the Model Additional Protocol entered into force with four states (the Holy See, Jordan, New Zealand and Uzbekistan). Additional protocols with a further 27 states were approved by the Board of Governors and were awaiting ratification by the respective states. The additional protocol with Australia, which entered into force in December 1997, was being implemented.

As of Dec. 31, 1998, additional protocols had been concluded and approved by the Board of Governors with a total of 38 states. Of these, additional protocols with

35 states had been signed, five had entered into force and one was being implemented. At the end of December 1998, 222 safeguards agreements were in force with 138 states (and Taiwan, China), although more than 30 states had still not concluded the requisite safeguards agreement with the agency. Of safeguards agreements in force, 59 states (and Taiwan, China) had declared nuclear activities and were being inspected, the majority pursuant to comprehensive safeguards agreements. In addition, safeguards were being implemented in the four states that have safeguards agreements covering specified nuclear or nonnuclear material, facilities and equipment and in the five nuclear weapon states, which have voluntary offer safeguards agreements with the agency.

There were 897 nuclear facilities and other locations under agency safeguards. Of these, 589 were inspected at least once in 1998. A total of 2,507 inspections were carried out, requiring 10,071 person-days of inspection effort in the field.

The expenditure from the Safeguards Regular Budget was $80,807,000 (U.S.). In addition, extrabudgetary funds of $14,991,000 were contributed by seven member states. The provision by several member states of extrabudgetary funds for equipment procurement helped to alleviate shortages of instruments and facilitated the replacement of some obsolete equipment. In the areas of research and development and safeguards implementation support, the Secretariat benefited from the technical support programs established in member states and in the European Atomic Energy Community (Euratom).

Other developments:

- The agency's safeguards obligations in Iraq continued to be subsumed in the mandate assigned to it by resolutions of the United Nations Security Council. The implementation of the agency's monitoring and verification plan in Iraq faced difficulties during the year and was suspended on Dec. 16, 1998. Since then, the agency has been unable to implement its mandate in Iraq and is unable to provide any measure of assurance about Iraq's compliance with its obligations.
- Following the statement of September 1996 by the secretary of energy of the United States, the minister for atomic energy of the Russian Federation and the director general of the IAEA relating to agency verification of excess fissile material, technical meetings took place in 1998 in the Russian Federation and in the United States. The Secretariat has continued its work on the preparation of a model verification agreement associated with such verification.

Canberra Awarded $20 Million Contract by Bechtel Jacobs

Canberra Industries has been conditionally awarded a subcontract valued at up to $20 million to operate multiple facilities that will perform nondestructive assay and nondestructive examination of wastes and materials at U.S. Department of Energy sites in Oak Ridge.

Canberra, headquartered in Meriden, Conn., with an office in Oak Ridge, Tenn., was selected following a competitive bid process by Bechtel Jacobs Co. LLC, the department's management and integration contractor for environmental management work in Oak Ridge, Paducah, Kentucky, and Portsmouth, Ohio. The fixed-unit price contract is for three years, with two one-year options.

Canberra will support workforce transition requirements by hiring displaced employees of Bechtel Jacobs Co. LLC, Lockheed Martin Energy Systems and Lockheed Martin Energy Research.

Partnering with Canberra on the project is EET TN Corp., American Technologies Inc. and Florida International University Hemispheric Center for Environmental Technology.

BNFL Instruments Teams with RADOS Technology in the U.K. and U.S.

BNFL Instruments has teamed with RADOS Technology Group to provide a full range of nuclear dosimetry and monitoring instrumentation to the U.K. market. The two businesses are also teaming in the United States to provide a range of environmental and workplace monitors to the country's nuclear industry.

Effective June 1, BNFL Instruments has assumed responsibility for all U.K. sales and service of RADOS products and will provide service support to existing RADOS customers.

In the United States, RADOS Technology and BNFL Instruments will combine their abilities to provide a comprehensive range of nuclear instrumentation with the objective of broadening the customer base.

RADOS environmental monitoring will be harnessed by BNFL Instruments to manufacture products at its New Mexico plant, beginning with a new range of alpha (plutonium) continuous air monitors. These products are the result of several years of technical development and represent a significant move forward in the state of the art, satisfying the increasingly stringent demands of the nuclear industry.

ADVERTISER INDEX

August 29–September 3
Global '99 International Conference on Future Nuclear Systems, Snow King Resort, Jackson, Wyoming. Sponsor: ANS Idaho Section. Contact: ANS; e-mail, global99@anlw.anl.gov.

August 30–September 3
International Symposium on Technologies for the Management of Radioactive Waste from Nuclear Power Plants and Back-end Nuclear Fuel Cycle Activities, Taejon, Korea. Sponsor: IAEA. Contact: IAEA; phone, (43) 1 2060 21270; fax, (43) 1 2060 29610.

September 6–12
International Symposium on Research Reactor Utilization, Safety and Management, Lisbon, Spain. Sponsor: IAEA. Contact: IAEA; phone, (43) 1 2060 21270; fax, (43) 1 2060 29610.

September 12–16
2nd Topical Meeting on Decommissioning, Decontamination, and Reutilization of Commercial and Government Facilities, Holiday Inn, Knoxville, Tennessee. Sponsor: ANS Division of Decommissioning, Decontamination, and Reutilization. Contact: ANS; phone, 708/579-8316; fax, 708/579-8314; e-mail, registrar@ans.org.

September 12–17
10th International Symposium on Reactor Dosimetry, Osaka, Japan. Sponsor: Atomic Energy Society of Japan, American Society for Testing and Materials, European Working Group on Reactor Dosimetry. Contact: David W. Vehar; phone, 505/845-3414; fax, 505/844-0798; e-mail, dwvehar@sandia.gov.

September 14–17
7th Topical Meeting on Emergency Preparedness and Response, La Fonda Hotel, Santa Fe, New Mexico. Sponsor: ANS. Contact: W.J. Flor; phone, 505/665-8768; fax, 505/665-4477; or R.F. Smale; phone, 505/667-9865; fax, 505/667-9726; e-mail, ans-er99@lanl.gov.

September 20–24
6th International Conference on Facility Operations-Safeguards Interface, Jackson Hole, Wyoming. Sponsor: ANS. Contact: Mike Ehinger; phone, 423/574-7132; fax, 423/574-3900; e-mail, mhe@ornl.gov.

September 20–24
6th International Conference on Nuclear Criticality Safety, Versailles, France. Sponsor: ANS Nuclear Criticality Safety Division. Contact: Patrick Cousinou; phone, (33) 146 547 421; fax, (33) 146 572 998; e-mail, incn99@ipsn.fr.

September 26–29
INFO/Crisis Communications, The Pfister, Milwaukee, Wisconsin, U.S.A. Sponsor: Nuclear Energy Institute. Contact: Conference Office; phone, 202/739-8000; fax, 202/872-0560.

October 3–6
NEI International Uranium Fuel Seminar 99, The Sagamore on Lake George, Bolton Landing, New York. Sponsor: Nuclear Energy Institute. Contact: Conference Office; phone, 202/739-8000; fax, 202/872-0560.

October 17–22
9th International Conference on Radiation Shielding, Tsukuba, Japan. Sponsor: JAERI. Contact: Yujiro Ikeda; e-mail, ikeda@fnshp.tokai.jaeri.go.jp.

October 17–22
NEI Training Seminar: Fundamentals of Nuclear Communications, Hyatt Regency Bethesda, Bethesda, Maryland, U.S.A. Sponsor: Nuclear Energy Institute. Contact: Conference Office; phone, 202/739-8000; fax, 202/872-0560.

October 18–21
Fire Protection Information Forum, The Don CeSar Hotel, St. Petersburg Beach, Florida, U.S.A. Sponsor: Nuclear Energy Institute. Contact: Conference Office; phone, 202/739-8000; fax, 202/872-0560.

October 18–21
Decommissioning Planning Forum, Marriott at Sable Oaks, Portland, Maine, U.S.A. Sponsor: Nuclear Energy Institute. Contact: Conference Office; phone, 202/739-8000; fax, 202/872-0560.

October 27–30
EP Shanghai '99 (2nd International Exhibition on Electrical Power Equipment and Technology) and Electrical Shanghai '99 (International Exhibition on Electrical Engineering, Electrical Equipment and Contractors' Supplies), Shanghai Exhibition Centre, Shanghai, China. Sponsor: State Power Corp. Contact: Eric Shew or Rebecca Fung; phone, 852 2811 8897; fax, 852 2516 5024; e-mail, aes@adsaleexh.com; Web site, http://www.adsaleexh.com.

November 14–16
ANS Nuclear Technology Expo, Long Beach Convention and Entertainment Center, Long Beach, California. Sponsor: ANS. Contact: Registrar's Office; phone, 708/579-8316; fax, 708/579-8314; e-mail, registrar@ans.org.

November 14–17
Institute of Environmental Sciences and Technology Fall Conference, Hyatt Regency Oak Brook, Oak Brook, Illinois. Sponsor: IEST. Contact: IEST; phone, 847/255-1561; fax, 847/255-1699; e-mail, iest@iest.org; Web site, http://www.iest.org.

November 29–December 3
International Symposium on Restoration of Environments with Radioactive Residues, Arlington, Virginia. Sponsor: IAEA. Contact: T. Niedermayr; phone, (43) 1 26000, ext. 21312; fax, (43) 1 26007; e-mail, T.Niedermayr@iaea.org.

November 30–December 3
EP Vietnam '99 (4th Vietnam International Exhibition on Power, Electrical Equipment and Contractors' Supplies), Kasati Centre, Ho Chi Minh City, Vietnam. Sponsor: Electricity of Vietnam and Adsale Exhibition Services. Contact: Anita Fong; phone, 852 2811 8897; fax, 852 2516 5024.