THE IMPORTANCE OF INTERNATIONAL COOPERATION IN THE FIELD OF HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT

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ABSTRACT

This paper discusses the importance of international collaboration in the field of radioactive waste management and points out how cooperation has benefitted the U.S. civilian waste management program.

The U.S. Department of Energy's Office of Civilian Radioactive Waste Management (OCRWM) oversees the handling, transportation, storage, and final deposition of high-level radioactive wastes for the U.S. commercial sector. Because OCRWM shares many of the same waste management concerns as various other countries with nuclear programs, and since one country's waste management program will ultimately have an impact on the waste management programs of other countries, it is clearly in the interest of all countries to work together in search of solutions to common waste management problems. To facilitate this cooperation, OCRWM is a participating member of international organizations, such as the IAEA and the OECD/NEA. OCRWM further has in place several bilateral agreements with various individual countries and with the Commission of the European Communities (CEC). Other international waste management initiatives are also currently being considered.

INTRODUCTION

The Department of Energy's (DOE) Office of Civilian Radioactive Waste Management (OCRWM) was created through the Nuclear Waste Policy Act of 1982 to manage and dispose of the nation's spent nuclear fuel and high-level radioactive waste in a manner that protects the health and safety of the public and of workers and the quality of the environment. To realize this mission, OCRWM has sought solutions to such challenges as the safe handling, transportation, storage, and final disposal of spent fuel and radioactive wastes requiring deep geologic disposal that arises from commercial and defense nuclear activities. Other nations using nuclear power as a source of energy are also faced with radioactive waste management issues similar to those experienced by OCRWM, and are developing their own programs to manage high-level radioactive wastes. These common radioactive waste management goals create numerous opportunities for international cooperation. The search for deep geologic disposal sites is an excellent example of a project for which international collaboration is vital, considering especially the complexity, magnitude and expense of such an endeavor. Constructing the safety case requires a detailed geoscientific characterization of a site and a conceptual design of a repository system. The design includes defining the waste form (spent nuclear fuel, solidified HLW), the containers surrounding the waste form, and the engineered components surrounding the waste containers (e.g., buffers, backfills). These types of activities involve research, development and engineering achievements which are as yet unprecedented and which will require a great deal of study and experimentation prior to implementation.

To realize the maximum benefit that can be obtained from these types of potential opportunities, OCRWM maintains a highly active and viable international program. The objectives of this program are to obtain information that will benefit the development and licensing of the federal waste management system, and further to promote consensus on radioactive waste management issues. The OCRWM international program is involved in many multilateral and bilateral activities. It is a participating member in two international organizations, and in addition maintains radioactive waste cooperative agreements with several individual nations and with the European Atomic Energy Community (EURATOM), acting through the Commission of the European Communities.

International collaboration has taken on increasing significance in the last decade. Experts in the field know that the success or failure of high-level waste management programs abroad will ultimately have an impact on programs at home. Cooperation allows the various nations to share, compare and learn from the results of others' work. Such interaction increases the collective understanding of relevant waste management issues and unites the views of the world scientific community about these issues. This consensus lowers the potential for negative impacts. There are many other benefits to international cooperation as well. For example, the need for international collaboration in resource intensive research projects in the forthcoming decade will increase as fiscal problems increase in both the U.S. and other nations. Other benefits include sharing experience, credibility, synergy, and international good will.

The purpose of this paper is to identify OCRWM collaborative activities with other nations and international organizations and to point out how these activities benefit the OCRWM program.

OCRWM PARTICIPATION IN INTERNATIONAL ORGANIZATIONS

The DOE maintains membership in the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA) and the International Atomic Energy Agency (IAEA). These organizations coordinate international cooperation on a host of issues related to the nuclear fuel cycle, including waste management.

OECD/NEA

The OECD Nuclear Energy Agency was formed in 1958, and its members are chiefly European states, although the U.S., Australia, Canada, and Japan also belong. The goal of this Paris-based organization is to promote the peaceful uses of nuclear energy through cooperation between member governments on safety and regulatory aspects of nuclear development and on assessing the role of nuclear energy in facilitating

economic progress. The OECD/NEA sponsors technical workshops and joint research projects in the field of radioactive waste management and also maintains several geochemical databases. DOE is an active participant in the OECD/NEA, and OCRWM's Director of the Office of Strategic Planning and International Programs is the official representative for the U.S. in the OECD/NEA Radioactive Waste Management Committee (RWMC). In addition, OCRWM supports and provides representation to the OECD/NEA Performance Assessment Advisory Group (PAAG) and the Site Evaluation and Design of Experiments Group (SEDE). The objective of PAAG is to provide an international forum to consider post-closure performance assessment for the safe disposal of radioactive waste. SEDE was created to improve information exchange between different site evaluation projects concerning methods of data collection, the design of experiments, and overall site evaluation.

One of the OECD/NEA's most significant activities was its long-term sponsorship of the International Stripa Project, which involved eight countries. Between 1980 and 1991, researchers used an abandoned iron ore mine in Sweden as a site for the international research on methods and technologies necessary for the deep geologic disposal of high-level radioactive wastes. The first two phases of the project, Phases I and II, were performed between 1980-1984 and 1984-1987, respectively. Phase I consisted of experiments designed to obtain information on logging systems for borehole hydrogeological measurements, geochemistry of groundwaters at great depth, migration rates of various elements in fractures, and behavior and utility of backfill materials in a real geological environment. Phase II focused on development of single hole and cross hole radar and seismic techniques for the detection and characterization of fracture zones in the vicinity of a repository, a three-dimensional tracer migration experiment, investigations of ground water fracture flow and associated nuclide transport, and borehole and shaft sealing tests. Phase III, which began in 1987 and ended in June of 1991, investigated fracture flow and radionuclide transport, groundwater flow-path sealing, and the development of remote sensing instrumentation. The work at the Stripa mine has benefitted OCRWM by enhancing the overall understanding of fracture-flow hydrology. Specifically, Phase III resulted in: 1) the development and use of a directional borehole radar system; 2) improved seismic methods for crosshole geophysical measurements to detect the compressional and shear-wave arrival times from a man-made or explosive energy source; and 3) improved understanding of cement and clay-based grout and sealing performance. The knowledge and experience gained through the Stripa Project will assist OCRWM researchers in their attempt to develop a deep geologic repository at Yucca Mountain, Nevada. For example, much of the Stripa research in fracture flow physics is applicable to the Yucca Mountain project, since tuff is highly fractured and existing regulations require a detailed understanding of water movement. In addition, each of the eight nations active in the project gained access to all of the resulting technology developments and experience, thus receiving a multi-fold return on their original investment.

Another major OECD/NEA undertaking has been the development of the Collective Opinion on Performance Assessment. The OECD/NEA RWMC, along with the IAEA International Nuclear Waste Management Advisory Committee (INWAC), sponsored careful, detailed studies of the most appropriate means for assessing the safety of various radioactive waste disposal practices. As a result of this review, the two committees confirmed that safety assessment methods which can satisfactorily evaluate potential long-term impacts of radioactive waste disposal systems are currently available. The committees further concluded that "appropriate use of safety assessment methods, coupled with sufficient information from proposed disposal sites, can provide the technical basis to decide whether specific disposal systems would offer to society a satisfactory level of safety for both current and future generations." The Collective Opinion provided important consensus in the field of performance assessment to OCRWM and waste management programs in other nations.

IAEA

The International Atomic Energy Agency (IAEA), located in Vienna, Austria, is an independent organization that belongs to the United Nations. It consists of 112 member states, including the United States. Like the OECD/NEA, the IAEA also has as one of its major objectives the development of peaceful uses of nuclear energy. In addition, the IAEA provides technical assistance to developing countries in the field of nuclear energy. With respect to radioactive waste management, the IAEA's chief objective is to assist member states in protecting both human beings and the environment from hazards arising from radioactive wastes and effluents. In order to fulfill its objectives, the IAEA sponsors various international seminars and conferences, and it prepares and disseminates documents on the subject of high-level waste management.

The development of the Radioactive Waste Safety Standards (RADWASS) series of documents is currently one of the IAEA's major international activities in the field of nuclear waste management. The RADWASS series is being developed to promote and demonstrate the consensus on approaches to safe management of radioactive waste that exists at the international level. Participation in IAEA's RADWASS program benefits OCRWM in that access to this information will enable OCRWM to ensure that U.S. views are considered in the development of international consensus on high-level waste management issues.

In the area of spent fuel storage, the IAEA has sponsored the BEFAST program (Behavior of Spent Fuel Assemblies During Extended Storage). BEFAST I was initiated in 1981 to provide the eleven participating nations with the opportunity to exchange information and evaluate data focusing on regulatory aspects of spent fuel storage. The topics addressed by the program included potential fuel degradation mechanisms during wet and dry storage, spent fuel examination and surveillance programs, and impact on storage facilities and equipment. A follow-up program, called BEFAST II, was initiated in 1986 to continue these studies. Thirteen countries currently participate in BEFAST II, and a BEFAST III is presently under consideration. Through participation in BEFAST, OCRWM obtained valuable information regarding the development and technical requirements for long-term spent fuel storage. This program also offers the United States an opportunity to assist in the development of international consensus on high-level radioactive waste storage issues.

To enhance the safety and transportation of radioactive wastes, the IAEA initiated the PATRAM (Packaging and

Transportation of Radioactive Materials) program over twenty-five years ago. PATRAM seeks to promote the exchange of scientific and technical information among member countries and facilitates the development of regulations for the transportation of radioactive materials. An international committee coordinates symposia, which are held every three years. Attendees include shippers, carriers, regulators, and designers and manufacturers of waste transportation equipment. Through participation in PATRAM, OCRWM has been able to influence the international standards developed by organizations involved in the U.S. waste transportation system and other program members. Participation also helps establish program credibility by providing countries with the opportunity to discuss and compare their general approaches to waste packaging issues.

BILATERAL AGREEMENTS

OCRWM currently maintains bilateral agreements in the area of high-level radioactive waste management with Belgium, Canada, France, Germany, Japan, Sweden, Switzerland, and the United Kingdom. Bilateral agreements allow nations to cooperate on issues relevant to both parties' specific needs. The bilateral agreements provide the vehicle required to implement the exchange of technical information and personnel, and for work on joint research projects.

CANADA

In 1976 DOE signed an umbrella agreement with the Atomic Energy Agency of Canada Limited (AECL). The agreement covers exchange activities in the area of waste treatment, packaging, storage, transportation, disposal, public acceptance, environment, and safety.

Two subsidiary agreements were created subsequent to this bilateral. Subsidiary Agreement Number One (S.A. 1) was established in 1986 to perform activities associated with underground research laboratory (URL) shaft extension, planning for in-situ tests, surface-based geologic characterization, and performance assessment code transfer. This agreement was set aside in June 1988 as a result of the Nuclear Waste Policy Amendment Act of 1987. Subsidiary Agreement Number Two (S.A. 2), established in 1991, focuses on activities supporting the evaluation of Yucca Mountain as a possible site for a geologic repository. Site characterization and validation, instrumentation, radionuclide transport, and sealing technology are areas of cooperation under this agreement. This agreement covers such tasks as natural analogue studies of buried uranium at Cigar Lake, instrument testing, verification of the total-system performance assessment code, and development of a model for spent fuel dissolution. Some of the benefits to OCRWM for participation in the project include: 1) use of the Canadian URL and Whiteshell laboratory experimental facilities, and access to the natural analog site at Cigar Lake; 2) access to extensive Canadian expertise in instrumentation development and laboratory testing; and 3) access to various databases and radionuclide migration computer models developed by the Canadians in support of their high-level waste management system.

SWITZERLAND

OCRWM also has a waste management agreement in place with the National Cooperative for the Disposal of Radioactive Waste (NAGRA) in Switzerland. The bilateral agreement was signed in 1985, followed by several Project Agreements on specific issues.

Project Agreement Number One (P.A. 1) was completed in 1987 and focused on creating a stochastic model for fracture hydrology. Data was obtained at Swiss sites and analyzed at Lawrence Berkeley National Laboratory in the United States. The objective of Project Agreement Number Two (P.A. 2) was the development and verification of models for hydrologic flow in fractured rock, the development of seismic instrumentation, and the interpretation of tomographic data. Project Agreement Number Three (P.A. 3) was signed in 1991. It covers fluid-transport characterization, multi-phase flow in fractured rock, seismic tomographic imaging, and the development of mechanisms for controlling sorption and borehole-fluid logging. The chief benefit of cooperation with Switzerland is that the technologies and methodologies developed under the project agreements will have application to Yucca Mountain site activities. The benefit will be realized through: 1) use the both underground and above ground experimental laboratories; 2) access to extensive Swiss expertise in surface and underground testing; 3) access to a myriad of characterization data collected throughout Switzerland; and 4) the ability of U.S. scientists to test in Swiss facilities and to develop and test models based on Swiss data.

COMMISSION OF EUROPEAN COMMUNITIES

Since 1982 OCRWM has also had an umbrella agreement with the Commission of the European Communities (CEC), consisting of twelve member states: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom. Although the CEC is comprised of several nations, OCRWM's activities with the organization are considered bilateral. The primary focus of the agreement is the Natural Analogue Working Group, which promotes the exchange of information on natural analogues and strives to develop consensus on the use of natural analogue studies in waste management systems. The group sponsors symposia and coordinates natural analogue studies with both CEC and non-CEC countries. OCRWM benefits from collaboration with the CEC by gaining crucial insights on the phenomenon of natural analogues, which are useful in understanding the geologic processes similar to those expected to be found in a geologic waste disposal system. Thus such studies have direct application to the OCRWM program and would eliminate the need for OCRWM to invest time and resources into carrying out independent studies.

MULTILATERAL COOPERATION

Another form of cooperation in which OCRWM is actively engaged is multilateral cooperation. Under this type of arrangement, several countries with similar waste management interests agree to participate in joint projects and studies on specific topics.

INTRAVAL

INTRAVAL is one example of a multinational activity. Initiated in 1987 and managed by the Swedish Nuclear Inspectorate, this project involves some twenty-one countries in a major effort to validate geosphere models for radionuclide transport. Phase One of the project was completed in 1990; detailed results will be published later this spring. Phase Two

of INTRAVAL began in 1991 and will test Phase One model predictions against actual results to be obtained in field-scale testing. Four Working Groups have been created for this purpose. OCRWM participates in Working Group One, which focuses on unsaturated-zone hydrology and transport. Participation in INTRAVAL has improved OCRWM's understanding of radionuclide transport and modeling and has greatly contributed to OCRWM work in validation of performance assessment models. Any U.S. validation process or demonstration in the future will likely be measured against INTRAVAL results. Collaboration on INTRAVAL also produced synergy, in that no individual country could successfully undertake this type of project independently. Participation enhanced the collective understanding of code validation by making the best thought and techniques available throughout the general research community.

POCOS DE CALDAS

Another major multinational effort was the Pocos de Caldas Project, carried out by Brazil, Sweden, Switzerland, the United Kingdom and the United States. The project was initiated in 1985 to observe radionuclide transport under oxidizing and reducing conditions at the Pocos de Caldas natural analogue site in Brazil. The possible influences of microbial activity and colloids on radionuclide transport were also analyzed. Work was completed in 1990, yielding a greater understanding of natural analogues and of radionuclide behavior in nature.

COOPERATIVE INITIATIVES UNDER CONSIDERATION

Because methods and technologies for successful waste management evolve rapidly, OCRWM continually looks for new opportunities for collaboration. Indeed, OCRWM is currently in the process of evaluating the possibility of various other international initiatives. Working with the Swedish Nuclear Fuel and Waste Management Company (SKB), OCRWM is reviewing the benefits of formulating an agreement to conduct cooperative studies at the Hard Rock Laboratory on the Swedish island of Aspo. Tests will be performed over a fifteen year period, starting in 1994. The objectives of these tests are to: 1) characterize flow and transport in fracture rock; 2) study excavation effects and two-phase flow; 3) conduct geochemical investigations using radiogenic isotopic methods and geochemical modeling; and 4) study underground construction methods.

Another international project being considered is a multinational natural analogue study at the Oklo uranium mine in Gabon, Africa. Like the natural analogue work currently being performed at Cigar Lake in Canada and at Alligator Rivers in Australia, it is hoped that this study at Oklo will support site characterization, waste package, and performance assessment studies for any candidate site.

OCRWM and France have also agreed to pursue the development of potential areas of cooperation in the field of high-level radioactive waste management. To date OCRWM has identified several areas in which technology developed for the French high-level waste management system could benefit the U.S. federal waste management system. Two specific areas that have been discussed with France are spent fuel transportation and engineered interim storage.

CONCLUSIONS

To summarize, nations pursuing the development of high-level radioactive waste management systems share similar goals, and this provides for the creation of numerous opportunities for international interaction and collaboration. Collaboration allows scientists and researchers to share, compare, and learn from the results of work performed by colleagues abroad. Collaboration enhances the collective body of knowledge in the field and reduces the potential for negative impacts. It also enables researchers to reach a consensus on the most important issues requiring consideration. Multinational cooperation further reduces costs to all participating nations when research facilities, equipment, and technical expertise are shared.

OCRWM is actively engaged in several international programs, both through participation in activities sponsored by international organizations, such as the OECD/NEA and IAEA, and through individual bilateral agreements with those nations sharing similar radioactive waste management concerns. OCRWM has benefitted immensely from its international collaboration, especially in the areas of geologic repository development, spent fuel storage and transportation. Specific project agreements focused on geologic repository development issues have been implemented with Canada and Switzerland, and efforts are underway to establish a project agreement with Sweden at its Hard Rock Laboratory. In addition, OCRWM is pursuing the identification of several other international initiatives to further enhance the federal waste management system.

Experience has shown that international collaboration has been highly beneficial to the OCRWM program. As a result, OCRWM will continue its commitment to international collaboration and will participate in those international activities which benefit the civilian nuclear waste management program.