

**CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES**

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**TRIP REPORT**

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**SUBJECT:** Disposition of High-Level Radioactive Waste Through Geological Isolation:  
Development, Current Status, and Technical and Policy Challenges

**DATE/PLACE:** November 4-5, 1999

**AUTHORS:** W. Patrick

**DISTRIBUTION:**

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# **CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES**

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## **TRIP REPORT**

**SUBJECT:** Disposition of High-Level Radioactive Waste Through Geological Isolation: Development, Current Status, and Technical and Policy Challenges

**DATE/PLACE:** November 4-5, 1999

**AUTHORS:** W. Patrick

### **PERSONS PRESENT:**

The subject workshop was attended by the author; J. Greeves and J. Kotra of the NRC; and waste management technical experts, programmatic leaders, and policy makers from more than 20 nations.

### **BACKGROUND AND PURPOSE OF TRIP:**

The International Workshop on the Disposition of High-Level Radioactive Waste (HLW) Through Geological Isolation, which was organized by the National Academy of Sciences (NAS) Board on Radioactive Waste Management (BRWM), was held November 4-5, 1999, in Irvine, California. Members of the Nuclear Regulatory Commission (NRC) and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff participated with over 200 representatives from more than 20 countries in a series of plenary and working group discussions on the development, current status, and technical and policy challenges associated with HLW disposition. Although the open dialogue raised a range of questions and concerns regarding various aspects of HLW disposal worldwide, the general tenor of the meeting was solution-oriented and forward-looking. Points of particular interest to the NRC and CNWRA include the importance of having a regulation in place early in the process, the difficulty of developing and maintaining stakeholder trust throughout the licensing process, the role of precedents from other countries and other waste management programs, the need to be prepared for "surprises" as site characterization and design progress, the importance of using multiple lines of reasoning to support licensing decisions, and the dilemma of making decisions in the face of residual uncertainty. The ultimate product of the workshop—a document updating the 1990 report "Rethinking High-Level Radioactive Waste Disposal"—is scheduled to be completed in a little over one year.

### **SUMMARY OF PERTINENT POINTS:**

The workshop was organized around seven topical discussion areas (see attached agenda), with plenary sessions to open and close the workshop. Because of the broad range of topics to be addressed, three "rounds" of discussions were held for each of the seven sessions. CNWRA and NRC staff participated in a cross-section of the topical sessions. Those that were attended by the author are reported here.

#### Opening Plenary Session

Following brief introductory remarks by M. Kavanaugh, Chairman of the BRWM, and D.W. North, Chairman of the workshop, the plenary commenced with a keynote address by F. Parker, Distinguished

Professor of Water Resources Engineering, Vanderbilt University and chairman of the NAS committee that produced the 1990 "Rethinking" report. He reviewed the 16 principles required for a "successful" HLW disposal program conveyed in that document, and highlighted that both scientific and societal factors must be considered. The need for peer review was emphasized, and he noted ~~that~~ <sup>that</sup> generally critical findings of the DOE peer review on total system performance assessment (TSPAI). In this context, he also observed that the regulatory requirement of "reasonable assurance" is a much lower standard than scientific understanding. A consistent theme throughout his presentation was the need for understanding that is both broad and deep; TSPAI cannot provide the entire basis for the repository safety case. The recent *Science* article by R. Ewing was noted in this context. Looking forward, Parker took monitored retrieval storage off the table, and discounted recent interest in transmutation, citing one estimate that it would take \$600B and 20-30 years to bring it to viability. He closed with two comments that were among the most controversial of the entire workshop: (i) a call for Congress to appoint a special committee to compare Yucca Mountain and the Waste Isolation Pilot Plant (WIPP), with an eye toward disposing HLW at the latter facility and (ii) a declaration without explanation that granting a license for YM would be a "Pyrrhic victory."

C. McCombie, former scientific and technical director of the Swiss National Cooperative for Radioactive Waste Disposal, presented the second keynote address, which reviewed the international program over the past 10 years. His remarks drew heavily from a 1999 Nuclear Energy Agency report on the subject. Looking at the "big picture," he cited inter-generational ethical concerns (e.g., minimum burden versus maximum choice), confidence building, and use of a phased approach as crucial aspects of HLW disposal. He also identified a number of key issues common to the international programs. These included (i) the need to consider long-term safety as well as current operational safety concerns, (ii) many technical questions remaining, (iii) the need for both designs and analyses to be "robust," (iv) the competing effects of "good" and "bad" science (e.g., he cited publications that showed projections beyond the age of the known universe), and (v) the need to incorporate what he referred to as unique perspectives of geologists in the analyses of performance. Significantly, he emphasized that the "most effective programs" are where the regulator and licensee are "on an equal footing" in the process. In this context, he noted that the regulator is an integral "part of the case" that is brought to the public (i.e., as distinct from being part of the case that is brought to a licensing board in the U.S. construct). Looking forward, McCombie noted that adequacy and transparency of the siting process, public involvement, retention of the concept that the repository decision is reversible, and an improved framework to aid progress internationally are important factors.

The third keynote was provided by P. Slovic, President of Decision Research and Director of Psychology, University of Oregon. He provided a rather general discourse on risk analysis, which comprises both risk assessment and risk management. Most of the material presented was work he, Kasperson, Demasio, and others have conducted over the past 15 years or so, and included a number of references to their publications. In referencing his 1991 *Science* article on risk perception, he noted that not much attention has been paid to the subject. Slovic stated that two fundamentally different modes of thinking—experiential and rational—are ongoing in every mind all the time. One takes precedent over the other depending on the individual and/or circumstances involved. Both must be addressed in communicating on HLW management subjects.

The keynote addresses were followed by four responses from an international cast of technical and policy leaders.

Remarks by D. Dreyfus, former Director of the U.S. DOE Office of Civilian Radioactive Waste Management, were primarily at the policy level. He noted that much of the public neither perceives nor agrees with the notion that HLW disposal somewhere is a foregone conclusion. His experience is that (i) continued storage at the reactors for many years, (ii) development of multiple interim storage sites, and (iii) ultimate disposal

in a single geological repository are seen by many as viable options for the foreseeable future. In this context, he observed that doing nothing “is not a benign choice,” that there are radiological and fiscal burdens associated with continued delay. Dreyfus also took issue with Parker’s call for using WIPP as a HLW disposal site, noting that there is “nothing in the WIPP experience” that would allow it to be used for HLW disposal.

R. Kemp, Galson Associates and Honorary Visiting Professor of Risk Management and Communication, University of Surrey, UK, focused on the role of public trust. He observed that although the public may not trust the organizations involved, they may be willing to “suspend their distrust” in exchange for information, power, control, and benefits. He mentioned that a new approach called environmental dispute resolution (EDR) has been introduced in Europe. It sets a lower goal of changing views on specific projects rather than changing overall attitudes, which are deeply embedded. The EDR approach appears to produce more implementable solutions, more rapidly, but has the disadvantages of yielding non-optimal outcomes and offering a framework for unbounded problem raising versus problem solving. From his experience, the key factors in successful implementation of a proposed action are transparency, openness (which, interestingly, he stated must begin within the organization), accessibility (to information and physical locations), ethical and equitable behavior, and consistency in the direction of the technical and programmatic approach.

Y. LeBars, President of the National Agency for Radioactive Waste Management (ANDRA), France, provided brief remarks from the perspective of the developer. Perhaps his most important point was that individuals do not know how to address collective risk in making decisions. Within most cultures, people desire and take on considerable individual risk (many societies encourage it). Those same cultures, however, expect that the societal or collective risk will be zero.

P. Nygard, President of the Nuclear Fuel and Waste Management Company (SKB), Sweden, stated that repository siting must be the result of an open and democratic process. He identified three main premises regarding the disposition of HLW: (i) it must be deep geological disposal involving multiple barriers, (ii) it must include provision for retrieval of the wastes, and (iii) it must be gradually implemented following intensive consultations. Speaking from the perspective of a private corporation charged with storage and disposal of HLW, Nygard identified several key roles for government. These include (i) set the rules and regulations; (ii) be a clear supporter of the process, but do not ordain any particular site; (iii) establish an acceptable system of trade-offs for the selected host community; (iv) provide a mechanism for independent oversight that involves international insights and national regulatory authority; and (v) identify a single party responsible for disposal and establish the necessary authority to implement the decision. Nygard took a strong position against current proposals to site one or more international repositories, noting that the world as a whole will be unlikely to accomplish what no one country can do within its own borders. He closed his talk with a call to develop a means to inform both the political systems and the public of all nations about the status of HLW programs internationally.

#### Session 1 (Round 1): Role of Total System Performance Assessment in Establishing the Acceptability of Geologic Repositories: An Interface Between Technology and Policy

This session was organized and hosted by J. Long and G. deMarsily. It comprised a series of full presentations, a panel of eight brief presentations, and an open discussion.

R. Anderson opened the session with a discussion of the TSPA for the Waste Isolation Pilot Plant (WIPP). He offered a key insight that, although they spent most of their time addressing concerns about data and models, the real problems arose with regard to the basic system description (i.e., geological characterization,

facility description, and waste characteristics). He stated that they involved the stakeholders in the TSPA beginning with development of the list of features, events, and processes (FEPs) that would be used. Anderson also described how they used TSPA to identify proposed work that could be cut, at a savings of \$180M and 20 months. During the question and answer period, R. Ewing (who was a member of the WIPP oversight board) characterized the WIPP TSPA as being done “diligently and conscientiously, but not compellingly.” In his view, the TSPA was most useful in providing a framework for thinking about the project, but caused much to be “missed” with regard to data and analyses that should have been available as multiple lines of evidence regarding site behavior and performance. A. Van Luik opined that the success of WIPP was due in part to the regulator “supporting” the project and wondered if other regulators could do the same.

J. Mather and J. Holmes gave the perspectives of the regulator and the developer, respectively, in events leading up to the failure of NIREX proposal to develop a Rock Characterization Facility (RCF) near the Sellafield site. Under British law, all construction activities are addressed by the Planning Authority. NIREX took advantage of this provision and sought approval of the RCF (which would become a geological repository subsequent to successful characterization) in the same way that “one would to put an extension on one’s garage.” When the public asked for involvement of the nuclear regulatory authority, NIREX refused, citing the applicable law. Ultimately, the Planning Authority rejected the petition, and the Secretary of State upheld their position. The Secretary cited poor design, scientific uncertainty, technical deficiencies, impacts on the environment, negative effects on the local scenic beauty, and other factors for the rejection. Mather identified five key reasons for the failure, and Holmes responded to each of these in turn. The following table summarizes their perspectives.

<b>J. Mather, Planning Authority</b>	<b>J. Holmes, NIREX</b>
NIREX defined a robust site selection process, then ignored it	TSPA identified a site that looked acceptable but was not in their original list; NIREX waited 6 years to tell anyone about the change
Scientific investigations focused on finding numbers to put in models, rather than improving understanding and reducing uncertainties	Site characterization was substantial; TSPA was used iteratively to guide characterization; they would do it “the same only better” next time
No dialogue with the Planning Authority or opposition groups, merely defending their own positions	Agreed with the Planning Authority
Over-emphasis on confidentiality, which led to the perception of a lack of openness	Generally agreed with the Planning Authority; they published quite a bit, but it was in the form of company reports
Pressure to proceed quickly	Both the corporation and the government encouraged NIREX to move rapidly to identify and implement a solution

A panel of eight practitioners in radioactive waste management (not all from the HLW field) addressed the topic of “limits to knowledge,” bringing forward various examples of where there was unexpected transport of radionuclides in the environment. These are summarized as follows.

- D. Prudic described the high percent modern carbon and tritium observed down gradient of the Beatty, NV, low-level waste (LLW) site.
- T. Wood reported on studies of americium migration from the Idaho National Engineering and Environmental Laboratory, where concentrations are off by a factor of 40 and transport times by 2 to 4,000 years relative to what was modeled. He suggested colloid transport as a possible cause.
- J. Fabryka-Martin summarized her Cl-36 measurements in the Yucca Mountain (YM) Exploratory Studies Facility. In addition to pointing out that the elevated concentrations were “near but not always on” fault zones, she stated that there are still questions about total flux in the fast paths, the mechanism of transport, and whether pulse or steady-state flow is occurring.
- R. Gephardt described the Hanford tank wastes and focused his remarks on the SX tank farm, where 120,000 to 185,000 gallons of radioactive effluent has leaked into the surrounding soils. Contrary to early calculations, measurements demonstrate that technetium, tritium, and iodine have reached the groundwater.
- A. Kirsting reported on the elevated level of actinides measured distant from certain nuclear weapons tests on the Nevada Test Site. Although concentrations were characterized as “quite low,” radiocolloids were detected about 1.3 km from the source. She offered the opinion without substantiation that this site is a “worst case” relative to YM.
- J. Carrera described apparent paradoxes in saturated single-phase flow. These included three orders of magnitude variation in hydraulic conductivity as a function of scale at Grimsel in Switzerland and a factor of 200 difference in porosity at the El Cabril site in Spain. He criticized TSPA for being slow to incorporate the effects of spatial variability and matrix diffusion in fractured rocks, which he believes explain his observations.
- A. Pek investigated the effects of density-driven flow on radionuclide transport at two Russian sites: Karachai Lake and Krasnoyarsk. He presented figures that indicate transport contrary to the hydraulic characteristics of the site, and argued that the density of fluids and the geologic structure (weathering profiles, in this case) were controlling factors.
- F. Parker briefly commented on the results of Pek, offered that “preconceived notions” have a negative effect on the investigation process, and called for people to approach the complexities of HLW disposal with an open mind.

There was general agreement that the siting process must include principles that allow participants to deal openly with unexpected information and results. Van Luik noted that the 1985 DOE TSPA showed “nothing much comes out” at up to 30 ky and that the 1995 calculations with “radical differences” in the models led to the same bottom line result. He characterized the YM results as “very conservative” and stated that there are still no performance impacts. J. Greeves expressed considerable concern about the “confidence shaking” results presented by most of the panelists. Several panelists responded that these observations are a characteristic of natural systems that must be considered in the process. It is also important to note that the effects of these “surprises” on the ultimate performance of the respective facilities/sites was not addressed.

### Session 3 (Round 2): The Regulator's Dilemma: Decision Making in the Presence of Uncertainty

The second round of this session, which was organized and hosted by R. Budnitz and A. Suzuki, took the form of an open-ended dialogue among the approximately 30 participants. A number of points were gleaned from the dialogue. T. Hanks expressed the view that the regulator should commit an equal or greater effort to communication with the public regarding their actions and the bases for them. The author noted that the public must be informed from the outset both how the process for public involvement will work and how public input to the process will be used. Unless expectations and reality are in agreement, there is great risk that the public will be displeased with the process.

T. Cochran stated in strong terms that changes to 10 CFR Part 60, withdrawal of 40 CFR Part 191, and disagreements between the regulators (i.e., NRC and EPA) have led to an "erosion of the regulator's credibility." He clarified that there is a general perception that the groundwater travel time requirement of the former and the collective dose standard of the latter were abandoned because the proposed repository site at YM could not meet the standard. His view was that, instead of rejecting the site, the regulators rejected the standard.

S. Norby and J. Kotra expressed the importance of communicating in language that is understandable to the public and that appropriately targets the audience.

P. Swift made a key point that the credibility of the applicant is directly affected by the credibility of the regulator and the associated regulation. The regulations must be clear, credible, and understandable (i.e., in terms of how public health and safety are protected). Furthermore, the regulator must have sufficient technical competence and experience to be and be perceived to be an effective independent voice in the process.

Several comments were made regarding the need to balance short-term risks—which arise during storage and repository operations—with long-term risks associated with disposal. Most of the emphasis to date has been on the latter. Although it was recognized that most applicants and regulators have in-depth experience in operations, there appears to have been little thought about how to balance the almost-certain short-term doses with the somewhat more speculative long-term doses that are projected to occur over 1,000s or 1,000,000s of years.

### Session 4 (Round 3): Public Acceptance in the Context of Social Distrust

The third round of this session was intended to bring the discussion of the preceding two rounds to a close and identify specific topical areas that warranted further investigation and, potentially, inclusion in the NAS report. The session was chaired by R. Kasperson and Claire Mays, who had also hosted the preceding discussions. Summaries were provided by three individuals, and the other participants weighed in with discussion.

D. MacLean, a professor of philosophy at the U.S. Naval Academy, opened with a critique of the NRC reactor program (credited to C. Starr), which he said takes the position that "we are not here to satisfy the public, but to protect it." MacLean takes the position that the public cannot be protected, or convinced that they are protected, unless they are first satisfied. There was fundamental disagreement on this point that went unresolved, with T. Cotton noting that future populations can only be protected; there is no one who can truly be "satisfied" on their behalf. Not surprisingly, MacLean and the other social scientists are convinced that they need to be involved because of the strong tensions and biases that exist. A pertinent point raised in this

summary was the notion of “procedural values” (i.e., the need for there to be agreement on and integrity in deciding on a process for decision making and a means to implement that process).

G. Rosa, a professor of psychology from Washington State University, emphasized the need for trust and the importance of process. In particular, he noted that in all human endeavor trusting another involves relinquishing some measure of control; conversely, mistrust is an effective way of maintaining (at least intellectually) some measure of control. Importantly, he noted that mistrust is an essential element of a well-functioning democratic society. Rosa also cited studies that show that distrust of the public by scientists generally exceeds that of scientists by the public. The obvious implication is that scientists and engineers (policy-makers, too) are afraid to involve the public because doing so requires trust, which in turn requires some loss of control over the outcomes.

The final speaker was P. Richardson, a geologist from the UK who has worked extensively in hearing processes for both proponents and opponents of actions that have environmental consequences. He reiterated the importance of trust and the need for it to be truly mutual. Both sides need to be prepared to “stretch” from long-held views and perspectives on optimum solutions to be able to reach agreement. Furthermore, he emphasized that both developers and regulators have to “be prepared to fail” and to be seen as having failed. In his view, this ultimate admission of not knowing everything, but being prepared to respond honestly (e.g., abandoning a site or changing a design) is essential in building trust.

A vigorous discussion followed the three summaries. Numerous points were made, with a few consensus views developing. Following are some of the perspectives offered.

- Early agreement on the decision-making process is essential (M. English).
- There were strong opposing arguments that radioactive waste management is a unique problem (e.g., S. Brown, UK) that requires a new paradigm in public interaction and decision making, and that it is just one of a number of such problems (e.g., W. Lawless, SRS Citizens Advisory Group) that should be addressed consistently with other environmental issues.
- The need to include elected officials in the process and in workshops such as these was emphasized (T. Cotton).
- Because of the longevity of the problem, HLW management requires an exceptionally long-term organizational commitment (T. LaPorte). The “quality of the organization” is vitally important and, in his view, explains why the people of San Francisco do not protest nuclear naval vessels and the people of Las Vegas do not protest nuclear weapons deployment at Nellis Air Force Base, but are vehemently opposed to nuclear power plants and the repository, respectively.
- The need for the applicant to be a strong advocate was expressed (T. Hanks), but there was no clear consensus on this point. Some thought that the applicant should remain neutral.
- In sharp contrast, there was general agreement with the statement that there must be a strong, impartial, and independent decision maker (P. Swift). The ultimate decision maker must be and must be seen as “neutral” with respect to the outcome (i.e., they neither gain nor lose by a yes or no answer).



- Three key attributes of an effective process were identified as (i) rules must be clear, established through involvement of all stakeholders, and set expectations for involvement and outcomes; (ii) responses by the applicant and regulator must be consistent with the rules over the entire time period of the process; and (iii) reciprocity must be developed and preserved with regard to trust, negotiations, compensation, and value/respect conveyed among the participants (W. Patrick).
- In this context, it was noted that while all of the detailed rules cannot be specified, there are basic principles that can be agreed to and applied broadly (M. English). However, others suggested that some of the general principles conflict or embody blind spots that are not known early in the process (W. Freudenberg).
- The concept of “limiting damage” to the host community was raised (T. LaPorte). As decisions are implemented and new knowledge and impacts arise, there are new or more severe “losers.” The process needs to include means to detect such shifts, identify those affected, and find timely remedies before the strain of loss grows beyond what can be borne.
- As a closing comment, LaPorte expressed some sympathy for the engineers and scientist who are being asked to “take on a whole new ethos” and “burden” regarding the sociological aspects of the projects that they undertake. He queried, perhaps rhetorically, as to whether engineers could have helped society progress to this point had they been saddled with this burden.

Questions that were raised but remained unresolved at the end of the session included (i) who represents the far future; (ii) flexibility in the process to meet local needs; (iii) importance of international review; (iv) transferability of results across processes, problems, and social constructs; and (v) the need for true leadership in initiating and eventually developing the process for going forward with each project.

### Closing Plenary Session

The closing plenary comprised relatively brief synopsis reports from each session, which are summarized as follows.

#### 1. Role of Total System Performance Assessment in Establishing the Acceptability of Geologic Repositories: An Interface Between Technology and Policy

Several key points were made. First, regulations must be set up ahead of time so criteria are clear; the process must include stakeholder involvement. Second, TSPA must be credible; to ensure credibility, multiple parties should conduct these assessments. Third, TSPA informs understanding of the system; differences between TSPA and field results should be expected and addressed in an iterative manner. Finally, achieving public acceptance will be difficult because of the lack of knowledge and large uncertainties involved.

#### 2. Timing and Staging Repository Development: Maintaining Technical and Social Balance in Stepwise Development from Concept Through Implementation

Six “tools” for a successful program were identified. These are (i) transparency, (ii) staging of characterization and development, (iii) use of underground research laboratories, (iv) constancy of policy over time, (v) flexibility and timeliness in responding to technical lessons learned, and (vi) retrievability or reversibility of emplacement.

3. The Regulator's Dilemma: Decision Making in the Presence of Uncertainty

This group stated that the crux of the matter is found in the regulatory statement that proof cannot be had in the ordinary sense of the word. It was emphasized that decisions must be technically correct, technically defensible, and engender trust. This group identified the key factors as (i) a phased approach, (ii) not over-prescribing detailed regulatory criteria early in the process, and (iii) the universally observed problems with implementing a strict compliance approach.

4. Public Acceptance in the Context of Social Distrust

Important aspects of waste management identified by this group included (i) it is a unique problem requiring unique processes and solutions, (ii) the long time frame involved, (iii) the high level of public fear, (iv) social distrust with the technology and the policy makers, (v) need for institutional constancy, and (vi) the need to address inequities and diverse values of affected parties. Public acceptance may not be an appropriate goal; finding an acceptable process and creating the "fabric" of roles, institutions, rules, etc. to support the process is perhaps more achievable and all that is necessary. The summary highlighted the "trust deficit" problem in the radioactive waste management area and emphasized that distrust is mutual.

5. Lessons Learned from National Programs: Tracing Routes to Success or Setback

This group concurred in the continuing applicability of the "Rethinking" NAS report. Geological disposal is still the preferred option for management of radioactive waste, although the construct has broadened somewhat to include longer-term storage. In most nations, the siting process has not been well defined and transparent to the public; this has universally led to problems. They emphasized that trust is built on program stability, open communications, and, to a large degree, the people and personalities involved. Competence, consistency, ability to engage in frank discussions, and the capacity to change are essential personal attributes. This group also echoed some of the earlier points about stage-wise implementation, need for stakeholder involvement, retrievability, and the ability to address surprises; and added to this list the need to integrate across disciplines and needs of the various parties.

6. Is Geological Disposal Required?

This group considered a range of options for HLW disposition, including leaving in place, transmutation, accelerator transmutation, special treatment of weapons-based materials, international repository collaboration, and deep geological disposal. Transmutation options were seen to require a long time and large costs to implement and are based on unproven technologies. Furthermore, deep geologic disposal will ultimately be required even for these methods of waste treatment. They concluded, however, that surface-based storage could be protective of health and safety for centuries, assuming that institutions do not fail.

7. Making Progress Through International Cooperation

International cooperation was seen as essential, although its value to the various participants varies, with small countries/programs gaining most from the cooperatives. Development of generic data sets was seen as a possible role, but differences in quality assurance requirements were seen as a potential impediment (U.S. requirements were summarily declared to be "ridiculous" without elaboration). The subject of an international repository was broached, but there remain major issues regarding conveyance of responsibility, safeguards and security, and economics. The speakers were proponents of using international funds to sponsor a repository in Russia, where the proceeds would underwrite the costs of demilitarization and

improve safeguards there. Somewhat tongue-in-cheek, the ideal candidate for an international repository was characterized as "broke, authoritarian, possessing a nuclear infrastructure, and have no neighbors, or at least no friendly ones." More seriously, a potential host should have common ethical views, a valid location, strong technology, good regulatory structure, a government that is accepted on the world scene, consent by both the host country and countries concerned with nuclear proliferation, and a commercial industry prepared to undertake the endeavor. The latter was linked to the recent PANGEA proposal to host such a repository in Australia.

**CONCLUSIONS:**

No particular conclusions are offered based on attendance at this workshop. The NAS report will be developed over the next year, and is anticipated to be widely published and read.

**PROBLEMS ENCOUNTERED:**

None.

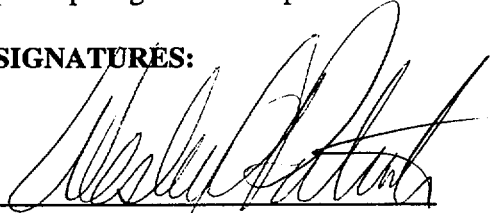
**PENDING ACTIONS:**

The author has committed to providing related references to the workshop organizers. No written inputs were requested, and none are currently planned. If the opportunity is afforded, it would be useful for the NRC and/or CNWRA participants in the workshop to review appropriate sections of the draft NAS report. As of the closing of the workshop, it was not clear whether an opportunity would be offered, given the tight schedule for producing the final report.

**RECOMMENDATIONS:**

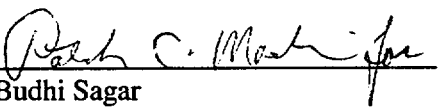
The management and technical staff of the NRC and CNWRA should continue to be actively involved in participating in workshops of this sort.

**SIGNATURES:**

  
\_\_\_\_\_  
Wesley Patrick  
President

11/16/99  
Date

**CONCURRENCE:**

  
\_\_\_\_\_  
Budhi Sagar  
Technical Director

11/16/99  
Date

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Board on Radioactive Waste Management

## **Disposition of High-Level Radioactive Waste Through Geological Isolation: Development, Current Status, and Technical and Policy Challenges**

**November 4-5, 1999**

**The Arnold and Mabel Beckman Center  
100 Academy Drive, Irvine, California, USA**

### **Workshop Final Agenda**

**Thursday, November 4, 1999**

#### **Plenary Session from 08:30–12:30**

08:30 Call to order and opening remarks

*Michael Kavanaugh*, Chairman, Board on Radioactive Waste Management

*D. Warner North*, Workshop Chairman

09:00 Keynote Addresses

*Frank Parker*, Distinguished Professor of Water Resources Engineering, Vanderbilt University and Chairman of authoring committee "Rethinking High-Level Radioactive Waste Disposal" (National Research Council, 1990), will speak on geological repository development in the U.S. since issuance of "Rethinking."

*Charles McCombie*, Former Scientific and Technical Director, the Swiss National Cooperative for Radioactive Waste Disposal, now International Consultant, will speak on international development of the geological disposition option during the past 10 years.

*Paul Slovic*, President, Decision Research, and Professor of Psychology, University of Oregon, will speak on perceived risk, trust, and the politics of nuclear waste management.

11:00 Perspectives on Keynote Addresses

*Dan Dreyfus*, Former Director of the U. S. DOE Office of Civilian Radioactive Waste Management

Discussion: How can a regulator meet the demands imposed by technical uncertainty, legal defensibility, transparency, formality, and public involvement?

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**Session 4: Public acceptance in the context of social distrust.**

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Organizers: *Roger Kasperson* and *Claire Mays*

Presentations:

- ◆ Public perceptions, *Peter Allen*
- ◆ Distrust and long-term institutional performance, *Todd LaPorte*
- ◆ Technology and values, *Armin Grunwald*
- ◆ Institutions, *William Freudenburg*

Discussion: Core issues in public acceptance and distrust.

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**Session 5: Lessons learned from national programs: Tracing routes to success or setback.**

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Organizers: *Roger Kasperson* and *Charles McCombie*

Presentations:

- ◆ Social issues, *Dan Metlay*
- ◆ United States programs, *Bob Neill (WIPP)*, *Chris Whipple* and *Russ Dyer (Yucca Mountain)*
- ◆ United Kingdom programs, *John Holmes* and *Neil Chapman*
- ◆ French programs, *Yves Le Bars*

Discussion and questionnaire: What factors have helped or hindered these national programs?  
*Neil Chapman* and *Tom Isaacs*

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**Session 6: Is geological disposal required?**

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Organizers: *John Ahearne* and *Nikolay Laverov*

Presentations:

- ◆ Problems in geological isolation, including matrices for HLW, *Nikolay Laverov*
- ◆ The separations technology and transmutation systems (STATS) report, *John Garrick*
- ◆ The accelerator transmutation of waste (ATW) roadmap, *Darleane Hoffman*
- ◆ Impact of the "leave in place" option, *Dee Walker*; comments, *Lake Barrett*

Discussion: General discussion.

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**Session 7: Making progress through international cooperation.**

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Organizers: *Charles McCombie* and *Ghislain de Marsily*

Presentations:

- ◆ Is international cooperation more trouble than it is worth? *Ian McKinley*
- ◆ What has the NEA done to improve international cooperation? *Claudio Pescatore*
- ◆ What has the IAEA done to improve international cooperation? *Arnold Bonne*
- ◆ Underground rock laboratories as a vehicle for international cooperation, *Bernard Neerdael*

Discussion: The scope and value of international cooperation, *Claudio Pescatore* and *Ian McKinley*

**5:30 RECEPTION AND BUFFET AT THE BECKMAN CENTER**

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**Session 6: Is geological disposal required?**

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Organizers: *John Ahearne* and *Nikolay Laverov*

Presentations:

- ◆ Selected summaries by Thursday afternoon and Friday morning presenters.

Discussion: Is a repository needed now?

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**Session 7: Making progress through international cooperation.**

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No evening session.

**Friday, November 5, 1999**

**Morning Discussion Sessions from 08:30–11:30**

The seven discussion sessions, Round 3. Each will begin with a summary of views expressed in the previous meetings of the session.

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**Session 1: Role of total system performance assessment in establishing the acceptability of geologic repositories: An interface between technology and policy.**

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Organizers: *Jane Long* and *Ghislain de Marsily*

Presentations:

- ◆ Credibility of TSPA for the public, *Michèle Rivasi* and *Andrew Stirling*
  - ◆ Can we make a repository more credible by engineering measures? *Charles Fairhurst*
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**Session 2: Timing and staging repository development: Maintaining technical and social balance in stepwise development from concept through implementation**

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Organizers: *Lars Ericsson* and *Peter Fritz*

The Thursday afternoon session is repeated.

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**Session 3: The regulator's dilemma: Decision making in the presence of uncertainty.**

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Organizers: *Robert Budnitz* and *Atsuyuki Suzuki*

The Thursday afternoon session is repeated.

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**Session 4: Public acceptance in the context of social distrust.**

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Organizers: *Roger Kasperson* and *Claire Mays*

Discussion and comments: Moving forward in the future, *Douglas MacLean*, *Gene Rosa*, *Phil Richardson*

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**Session 5: Lessons learned from national programs: Tracing routes to success or setback.**

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Organizers: *Roger Kasperson* and *Charles McCombie*

## **Saturday, November 6, 1999**

- 08:00 Steering committee meeting to discuss preparation of the final report (A peer-reviewed National Academies report to be completed in spring, 2000). Members of the advisory committee, session leaders, and other interested participants are invited to attend this meeting and to present comments.
- 12:00 Closed session of the steering committee
- 1:30 Adjourn the steering committee meeting