Nuclear Wastes: The Science of Geologic Disposal Seen as Weak

For more than 20 years deep geologic disposal has been regarded as the leading technical option for getting rid of the most dangerous and troublesome forms of nuclear wastes,* with salt formations generally viewed as the most promising of the geologic media considered. Moreover, an assertion often made by government officials, scientists, and engineers associated with the waste management program has been that the feasibility of the geologic disposal concept is not in doubt. For instance, in late 1976 a top official of the Energy Research and Development Administration declared that fulfillment of ERDA's plans to establish six deep geologic repositories, with the first (in salt) to be available by 1985, would require only "straightforward technology and engineering development."

It comes as a surprise, therefore, to discover now that there seems to be an emerging consensus among earth scientists familiar with waste disposal problems that the old sense of certitude was misplaced. Although these scientists continue to find the concept of geologic disposal attractive intuitively, some are stating explicitly that the scientific feasibility of the concept remains to be established. What a number of others are saying, while less direct, seems to add up to pretty much the same thing.

An as yet unofficial paper by the White House Office of Science and Technology Policy (OSTP) staff, prepared in connection with the work of an alternative technology strategies panel of President Carter's recently appointed waste management task force, bears directly on this point. In cautious bureaucratic language it speaks of a "rather general consensus" in the relevant technical community "that the knowledge and technology base available today is not yet sufficient to permit complete confidence in the safety of any particular repository design or the suitability of any particular site."

Accompanying this statement is the observation that there is also a consensus that geologic disposal can ultimately be achieved safely and that, "given sufficient time, investment, and scientific study, the required knowledge can be obtained." Nonetheless, inasmuch as this paper clearly reflects the thinking of investigators at the U.S. Geological Survey (USGS) and of at least some officials at the Department of Energy (DOE), its acknowledgment that a secure scientific foundation for geologic disposal is still lacking points to an important milestone in official deliberations over radioactive waste management.

Indeed, tangible evidence that the concept of geologic disposal is undergoing reappraisal can be found in the USGS, the Environmental Protection Agency (EPA), and in the DOE itself. For example, in their recent circular† on geologic disposal, five USGS scientists observed:

> The authors . . . are confident that . . . the ultimate decision on the acceptability of a given site and waste-handling procedure will have a strong scientific and technical foundation. However, some key geologic questions are unanswered, and answers are needed before the risk associated with geologic containment can be confidently evaluated. . . . We consider [in the circular] a variety of possible interactions among the mined opening of the repository, the [heat-generating] waste, the host rock, and any water that the rock may contain. Many of these interactions are not well understood, and this lack of understanding contributes considerable uncertainty to evaluations of the risk of geologic disposal of high-level waste [or spent fuel from power reactors in the absence of reprocessing].

A panel of eminent earth scientists which has made an evaluation for EPA of the state of knowledge relevant to geologic disposal has put the matter much more strongly. In a draft report submitted to the agency in March, the panel, cochaired by Raymond Siever of Harvard University and Bruno J. Giletti of Brown University, said: "We are surprised and dismayed to discover how few relevant data are available on most of the candidate rock types even 30 years after wastes began to accumulate from weapons development. These rocks include granite types, basalts, and shales. Furthermore, we are only just now learning about the problem of water in salt beds, and the need for careful measurements of water in [salt] domes."

Earlier, in discussing salt as a disposal medium, the panel observed that, while salt has seemed suitable partly because of its apparent dryness, close inspection reveals that the crystals contain significant amounts of water in fluid inclusions and "intergranular boundaries." The inclusions can "decrepitate," or burst, upon being heated to comparatively low temperatures, and, according to the panel, this "means that they are reasonably certain to do so in the vicinity of the [waste] canister as the temperature rises following emplacement. It is quite likely that the decrepitation will occur in the general vicinity of 150°C. If we take the wall temperature of the canister to reach 300°C, a significant amount of water might be available. There is a high likelihood that this is so in bedded salts. It becomes imperative to determine if similar amounts of water exist in the salt of salt domes."

[William C. McClain, technical projects manager with the Oak Ridge National Laboratory's Office of Waste Isolation (OWI), says that the existence of water in salt actually has been known since 1958. Moreover, the phenomenon of brine migration toward waste canisters was recognized by scientists at Oak Ridge as early as 1966 but the effects projected were considered too slight to be of concern—an assessment which according to McClain, OWI scientists continue to view as probably correct. What is new is that certain other investigators have now come to believe that the effects of the brine migration could be much greater than the OWI researchers think, and that it therefore may pose a threat to repository integrity. Prominent among these investigators is David B. Stewart, chief of the USGS experimental geochemistry and mineralogy branch.]

The DOE waste management task force report of last March referred to an "independent technical consensus" that high-level waste and spent fuel "can be safely placed in geologic media for ultimate disposal" and indicated that it remained only to develop the "detailed information" necessary to support the "specific choices of geologic medium, site, and repository design." But John M. Deutch, DOE's director of energy research and the official who formed the task force, apparently feels that the re-

*These would be the high-level waste from reprocessing plants, and, in the absence of reprocessing, the assemblies of spent fuel rods from nuclear reactors. Also, there are those low- to intermediate-level wastes contaminated with transuranic elements, especially plutonium, which has a half-life of more than 24,000 years.

†J. D. Breckhoeft, A. W. England, D. B. Stewart, N. J. Trask, I. J. Winograd, *Geologic Disposal of High-Level Radioactive Wastes—Earth Science Perspectives*, Geological Survey Circular 779. Available at no charge from Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

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search needed to support a sound program of geologic disposal is of a much more demanding and fundamental nature than the above would seem to suggest.

Indeed, in January Deutch asked William C. Luth, a Stanford professor of geochemistry then serving temporarily in DOE's office of basic energy sciences, to prepare a memorandum on the research needed for waste disposal. The paper was forthcoming shortly thereafter and Deutch praised it as "outstanding." Luth was sharp in his criticism of what he regarded as an unseemly emphasis in the waste management program on demonstrating the technical feasibility of geologic disposal instead of on arriving at a scientifically objective assessment.

"In my judgment," Luth said in a covering letter, "the most important need in the waste disposal program, relative to geologic isolation, is a major change in management (or management philosophy) at the Washington and field level. This is coupled with a vital need to obtain *and use* the very best scientific input available. If serious efforts are to be made regarding assessment of scientific feasibility of geologic isolation of radioactive waste, then it is essential to get new blood involved in the management and conduct of the research program."

Luth acknowledged that he did not undertake preparation of the report with "clean hands," for he had been critical of the "underlying philosophy and conduct" of the waste management program ever since he attended an ERDA-sponsored conference on high-level waste management in early 1975.

As Luth told Deutch, after attending that conference he wrote a strongly critical letter to Frank K. Pittman, who was then director of ERDA's Division of Waste Management and Transportation (Pittman has since left government). He complained that the majority of the presentations made had had to do with "paper studies" that focused on evaluation of alternatives for decision-making. "As an experimental geochemist reasonably familiar with the available basic data on materials interaction at high pressures and temperatures." Luth said, "I suggest that this data base is totally inadequate for meaningful evaluation of alternatives."

"Why do we not simply get on with the business of obtaining the requisite data, rather than continuing the extensive paper studies?" he added. "I should note that this problem is well recognized by researchers (as contrasted with man-

Congressional Committees Ponder Whether to Give States

The resistance and discouragement the Department of Energy (DOE) has met from the states in its search for sites for geologic repositories for nuclear wastes is now receiving a lot of attention on Capitol Hill. In fact, if what has been going on in two House and Senate committees is any measure of things to come, Congress is likely to try to induce the states to cooperate by guaranteeing them a major voice in the site selection process and perhaps at least a qualified right of veto. Also, the idea that repositories will have to be accompanied by substantial impact aid or outright economic incentives for the states in which they would be built is receiving increasing currency.

In its recent report on the coming fiscal year's DOE spending authorization, the House Committee on Interior and Insular Affairs observed that, even as things now stand, the states have what in practical political terms amounts to a "de facto" veto power over the siting of repositories. "Public concern over the safety of nuclear waste facilities has been so high that it has become politically necessary to assure states that repositories will not be sited inside their boundaries if the states do not concur in the plans," the report said. "Such assurances have been given by the Department to New Mexico, Louisiana, and New York, where potential waste disposal sites are located."

When Secretary of Energy James R. Schlesinger appeared before the Interior committee in late April, Representative Morris Udall (D–Ariz.), the chairman, told him: "We will probably have to give the states a veto. . . . If we face this, and accept it, then we can go out and persuade them [to accept a repository] a little more easily. The hard way may be the easy way."

For his part, Schlesinger agreed that, despite the general power of preemption conferred on the federal government by the Atomic Energy Act of 1954, it would be "inappropriate" or "impossible" to try to override public sentiment and site a repository in a state without that state's concurrence. But he disagreed with Udall's view that Congress should give the states a statutorily guaranteed right to a veto. "As a practical matter, the states have a right of concurrence," he said. "Whether under the law that is the case, I think would best be left unresolved. It is a gray area of the law and I think it is more convenient to leave it there rather than to define it too precisely."

Udall

Domenici

Hart

In the Senate, the push for legislation to clear up this "gray area" and guarantee the states a right of veto is coming from Senator Pete V. Domenici (D–N.M.), a member of the Subcommittee on Nuclear Regulation. His concern arises from the fact that DOE is planning to build in a bedded salt formation near Carlsbad, New Mexico, the first permanent geologic repository to be established anywhere.

Some New Mexicans are already flatly opposed to this project, known as the WIPP (for Waste Isolation Pilot Project), and many others are apprehensive about it. The present plans for WIPP call for a pilot repository for low and intermediate level transuranic military wastes (which emit relatively little heat compared to high-level wastes and spent reactor fuel and pose less of a threat to repository integrity), plus some experiments with disposal of military high-level wastes and a modest demonstration of disposal of spent fuel from commercial reactors.

But the government's past record in defining the scope of WIPP has been marked by no little confusion and evasiveness (*Science*, 10 March). Domenici and his constituents are on their guard lest the DOE surprise them with plans

agers) in the various captive contractor laboratories. However, it is doubtful whether they would be willing to so state in public for rather obvious reasons."

Luth further observed that he had found "very disconcerting" suggestions made at the conference that ERDA should seek to win public acceptance for geologic disposal by carrying out a pilot scale demonstration in bedded salt which would "prove"—not merely test—its feasibility. According to Luth, the general philosophy expressed by ERDA personnel at the meeting could be paraphrased as "let's go with bedded salt, but explore in a casual way other alternatives so we can demonstrate to the public that we have evaluated other methods. . . ."

Luth, who got no reply from Pittman, told Deutch that although funding for waste management had increased dramatically since 1975, he could see no reason to change the conclusion that he had come to at that time. In an interview with *Science*, Luth, who is now back at Stanford, expressed high confidence in Deutch himself, and said that future DOE research budgets would reflect a significantly greater emphasis on establishing a sound scientific base for geologic disposal. Deutch confirms this and indicates that, even under the current fiscal 1978 budget, the funds earmarked for near- and long-term scientific studies in support of geologic disposal are substantial, amounting to more than 10 percent of the total operating budget of $79 million for the commercial and military waste terminal storage programs. The very fact that Deutch, DOE's director of research, has been designated the senior official for waste management policy suggests that the waste program's scientific side is on the upswing.

The presidential task force on waste management has a mandate to submit recommendations to the White House by 1 October for an Administration policy on the long-term disposal of wastes. In light of the consensus that seems to be emerging that the present waste program lacks a sure scientific footing, some surprising developments may be in the offing. There could, for instance, be some deemphasis of salt as the preferred geologic medium in favor of a broader and deeper investigation of the available alternatives. These might even include an examination of such nonconventional approaches as disposal of wastes in super-deep holes and emplacement in the deep seabed.—LUTHER J. CARTER

a Right of Veto over Radioactive Waste Repositories

for a spent fuel or high-level military waste repository.

As for the assurances from DOE that neither the pilot project for disposal of transuranic wastes nor the spent fuel demonstration will be carried out without state concurrence, Domenici regards them as well and good but still not enough. What he wants is an ironclad congressional guarantee on which the government could never renege. Domenici feels it is vital for New Mexico and other states to have a right of veto because, in his view, it is not yet scientificially established that geologic disposal offers "reasonable assurance" of isolating wastes from the biosphere for the hundreds of thousands of years required.

Senator Gary Hart (D–Colo.), chairman of the nuclear regulation subcommittee, is ambivalent about giving the states a veto. On the one hand, he finds the proposal appealing because of its potential for making members of Congress think through and reveal their real attitudes about nuclear power. "A lot of people around here who have been voting nuclear subsidies may take a different attitude now that the chickens are coming home to roost," he says. But Hart is troubled at the possibility that all states might refuse to accept repositories even if they could be built without undue risk.

As an alternative to the Domenici proposal and a "safety valve," Hart has suggested that the states be given a qualified right of veto, with the President authorized to override a state's decision should this be in the national interest. But Hart, along with Domenici and Representative Udall, is persuaded that all geologic repository projects, including demonstration projects, should be made subject to licensing by the Nuclear Regulatory Commission (NRC). Domenici regards this as particularly important because, as he sees it, formal licensing proceedings will afford the state governments the best opportunity to evaluate repository projects and decide whether they represent an acceptable risk.

Legislation to close existing gaps in the NRC licensing authority over repositories does in fact seem likely to be passed within the next year or so. Both NRC and DOE favor such action. The House Committee on Armed Services, fearing delay, does not want the pilot transuranic waste repository proposed for New Mexico to be subject to licensing; but its attitude may be out of touch with the political realities to which most members of Congress are likely to respond.

Whether Congress will give the states an outright power of veto is more speculative. Some key members such as Representative John Moss (D–Calif.) of the Committee on Interstate and Foreign Commerce (which shares jurisdiction over DOE with the Interior committee) believe that such a grant of authority to the states would tend to compromise the federal system. But this objection would not seem to apply to a state veto which the President could override.

However this issue is decided, there will remain the basic political question whether a repository can be built in any state without a terrible fuss. Udall has suggested, and "only partly facetiously," that states that are found to have suitable sites be invited to compete for repositories on the basis of their minimum demands for jobs, tax breaks, and the like. Senator Hart also says. "The only way I can see it [the states' accepting repositories] happen is to sweeten it with jobs."

Governor Jerry Apodaca of New Mexico has already made it plain that, if his state goes along with WIPP, substantial federal impact aid will be expected for such things as housing and community facilities for construction workers, rerouting highways and railroads to avoid movement of wastes through population centers, and compensating the state for the loss of any potash and oil and gas resources placed off limits to development. Clearly, New Mexico and other states which turn out to have prime repository sites will be able to demand a high price as a condition for accepting the wastes, and Congress and DOE may find that there is no practical choice but to pay it.

—LUTHER J. CARTER