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## CHAPTER FIVE

TECH DOCS

# Radioactive Waste Disposal:

## The Atomic Energy Commission Brings the Academy to Heel

"The Academy is a valuable asset to the nation; its success in its advisory role to government rests on a fragile and complex web of confidence: public confidence in the integrity and independence of the scientists who serve without pay on its many committees; agency confidence that they will receive usable advice given in a spirit of helpfulness, and that they will not be pilloried for either real or fancied wrongs. If the one confidence waned, the [Academy's] . . . value to the nation would be severely depleted; if the other confidence were eroded, the Academy would indeed be out of business, for no agency would contract with it for advice. If one knows this operational frame, one understands why the Academy tends to be circumspect in its dealings with sponsoring agencies and close-mouthed about them afterward."

—Earl Cook, former Academy staff officer, explaining why the Academy allowed the AEC to suppress one of its reports and fire one of its committees, in a letter to U.S. Senator Frank Church (D-Idaho), May 1, 1970.



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The Academy's efforts to advise the Atomic Energy Commission (AEC) on disposal of radioactive waste materials reveals how difficult it is for the Academy to function as an effective critic of government. Since the mid-1950s, the Academy has been advising the AEC on the possibility of burying wastes deep beneath the earth in stable geologic formations. For the first decade of this effort, the Academy adopted an aggressive, independent stance. It suggested avenues of investigation which profoundly shaped the AEC's approach to the problem, and it was highly critical of existing waste management operations at AEC installations.

But the critical views were buried by the AEC, with Academy acquiescence, and the committee which authored them was disbanded at AEC insistence. It was replaced by a new committee closer in philosophy and background to the AEC's own thinking. Although the new committee has not been a mere rubber stamp for the AEC, its reports have tended to be supportive of AEC plans. Opinions differ as to whether the new committee or the old committee is more sound in its judgments. But whatever the merits of their respective positions, the circumstances surrounding this particular Academy advisory effort suggest that the Academy has identified too closely with the interests of the sponsoring agency—to the detriment of independence in behalf of the public interest.

Radioactive wastes present one of the major unsolved problems facing the nuclear age.<sup>1</sup> Such wastes are generated wherever radioactive materials are used. The mining, milling, and preparation of uranium fuel for reactors and weapons, the irradiation of nuclear fuels in reactors, the chemical processing of irradiated fuel to recover usable uranium and plutonium—all these and other steps in the handling of radioactive materials produce wastes that are extremely toxic. The great bulk of the wastes produced so far has been generated by the AEC itself, mainly as a

byproduct of weapons manufacture. But, as civilian nuclear power plants continue to proliferate, commercial wastes will become increasingly troublesome. The wastes range in toxicity from the so-called "low-level wastes," which are released to the environment after dilution or simple processing, through "intermediate-level wastes," to the "high-level wastes," which pose the greatest health hazard and the most complex technical problems of management. The only practical way to reduce the radioactivity in these wastes to nonhazardous levels is to allow the radioisotopes to decay naturally, a process which takes hundreds of years in the case of such toxic substances as strontium and cesium and perhaps 200,000 or more years for plutonium 239. Thus a secure means must be found to keep these wastes isolated from the environment, and particularly from the food and water supply, for centuries.

The wastes generated so far—some 80 million gallons as of 1971—have been stored in tanks or other holding facilities on an interim basis. In theory, such storage in adequately designed tanks could protect the public indefinitely, but the tanks deteriorate in a matter of decades, which means they require extensive surveillance, continuing maintenance, and perpetual replacement—all for periods longer than the life expectancy of governments. Thus the AEC—which is responsible for managing its own wastes and for regulating the wastes generated by the commercial nuclear industry—has been seeking some spot in the universe where the wastes can be placed and more or less forgotten. Alternatives that have been suggested range from shooting the wastes into outer space (a costly procedure which involves the hazard that a rocket might go astray and dump the wastes right back on earth) to burying the wastes in various geologic strata deep beneath the earth. So far, no final solution has been found. The permanent disposal of radioactive wastes remains one of the "most troublesome problems" confronting the nuclear enterprise, according to Alvin M. Weinberg, director of the AEC's Oak Ridge National Laboratory and a member of the NAS as well.<sup>2</sup>

The Academy was first asked in 1954 to help the AEC evaluate methods of burying the high-level wastes underground. A steering committee was formed which sponsored a major conference of experts at Princeton University in

September 1955; and a more permanent committee was set up in late 1955. The committee had a geologic focus and remained part of the Academy's earth sciences division for more than a decade. Although its membership changed gradually over the years, and its name changed as well—it was the Committee on Waste Disposal from 1955 to 1960 and the Committee on Geologic Aspects of Radioactive Waste Disposal thereafter—the group was essentially a single continuing committee. It repeatedly argued that the AEC was pursuing expedients that might jeopardize the safety of future generations, and it deliberately adopted a critical stance aimed at goading the AEC into adopting what the committee regarded as sound disposal practices.

The committee's first major report, published in 1957, warned that "The hazard related to radioactive waste is so great that no element of doubt should be allowed to exist regarding safety." It recommended that the wastes should not come into contact with any living thing during their period of toxicity, which might be six hundred years or more. And it concluded that the wastes could safely be stored in stable geologic formations beneath the earth. The committee particularly favored disposal in caverns mined in salt formations, preferably after the liquid wastes had been converted to a more immobile solid form.<sup>3</sup>

The suggestion that the wastes be buried in salt formations was a major contribution by the Academy toward resolution of the problem. Salt has many advantages as a disposal medium—it flows plastically, thus healing any fractures which might develop and effectively sealing in the wastes once they are buried; it is a good radiation shield; it dissipates heat better than other types of rock; it is found in areas that are free of earthquake hazards; it has almost always been geologically stable for millions of years; and its very existence is evidence that it has not been in contact with water or else it would have dissolved.<sup>4</sup> Burial in salt seems to be the favored long-term solution in both the United States and West Germany, and the Academy deserves major credit for focusing attention on salt's desirable features. The Academy committee functioned creatively in this instance. It did not merely review AEC plans and pick the best alternative; it actually produced a new idea that pushed AEC programs in a new direction. Even the

AEC acknowledges that the Academy "first suggested the use of salt formations."<sup>5</sup>

The committee and the AEC soon came into conflict, however, most notably over the choice of a location for permanent waste storage. The committee wanted the AEC to use the best possible geologic structures, but the AEC, for budgetary and convenience reasons, wanted a disposal site at each of the major AEC plants where high-level radioactive wastes are generated—the Hanford Plant in the state of Washington, where plutonium for nuclear weapons is produced; the Savannah River Plant in South Carolina, also a weapons facility; and the National Reactor Testing Station in Idaho, where nuclear reactors are built and tested. "They pressured us right from the start that they wanted a disposal site at each of these plants," recalls M. King Hubbert, a geophysicist who was associated with the committee for most of its existence. "They never let up on this. They kept harassing us."

In 1960, the committee took the unusual step of voicing its concerns in a letter to the AEC commissioners rather than to the Division of Reactor Development and Technology, the subunit of the AEC which the committee was officially advising. Summing up its conclusions after five years of advisory work, the committee said:

"No existing AEC installation which generates either high-level or intermediate-level wastes appears to have a satisfactory geological location for the safe local disposal of such waste products; neither does any of the present waste-disposal practices that have come to the attention of the Committee satisfy its criterion for safe disposal of such wastes."<sup>6</sup>

The committee recommended that "urgent" action be taken to establish facilities at suitable geologic sites where the wastes that had accumulated thus far could be safely disposed of. It also urged that plans for safe disposal of radioactive wastes be made a prerequisite for approving the site of any future installation by the AEC or under its jurisdiction, and that the AEC consider concentrating its chemical processing activities at a minimum number of sites located in satisfactory places. The committee which authored this letter had a distinguished membership. It was chaired by the late Harry H. Hess, chairman of the geology

department at Princeton University, who was a member of the NAS, and it included two other NAS members as well, namely Hubbert and Richard J. Russell.\*

The AEC delayed six months before answering, then gave the committee a polite brush-off, commenting that the committee's proposals were costly and unnecessary.<sup>7</sup> In 1970, the agency elaborated on this theme still further. "To comply with the Committee's recommendations," it said,

AEC would have had to abandon fuel reprocessing and radioactive waste management facilities and activities at each of the above sites [Hanford, Savannah River, and NRTS in Idaho]. It would have had to acquire an extensive new site or sites, presumably located over either salt beds or deep synclinal basins, since such locations appeared most attractive to the Committee for disposal of waste. It would have had to construct new fuel processing facilities and waste management facilities at the new site and move existing radioactive wastes from existing sites to the new site for disposal. Such an undertaking would have involved the expenditure of billions of dollars.<sup>8</sup>

The AEC was apparently so miffed that it stopped using the committee. Thereafter, according to Hubbert, the committee had "practically no further duties except for trivialities." Until 1963, that is, when Hubbert became chairman of the earth sciences division of the NRC and promptly set in motion events that were to bring the committee into direct confrontation with the AEC. "I told them I didn't propose to keep any committee standing around twiddling its thumbs," he recalls. "I said they should either discharge it or give it something worthwhile to do." The AEC, with some misgivings, agreed that the committee should undertake a review of the waste disposal research and development program of the Division of Reactor Development and Technology, the unit of the AEC which the committee had been advising. The reactor division is concerned with radioactive wastes resulting from the nuclear power industry; other parts of the agency are responsible for the wastes generated by the AEC itself.

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\*The other members included John N. Adkins, William E. Benson, John C. Frye, William B. Heroy, and Charles V. Theis. William Thurston served as secretary. Three members of the committee—Russell, Hless, and Adkins—had served as chairmen of the NRC earth sciences division, while a fourth (Hubbert) would later serve in that post.

In April and May of 1965 the committee visited the principal AEC disposal sites—Hanford, Savannah River, NRTS in Idaho, Oak Ridge, and experimental salt mine facilities in Kansas.\* At each site the committee was briefed on research sponsored by the reactor division. It also inspected the actual operating facilities used by contractors to dispose of the AEC's own wastes. Afterward, the committee drafted a report that discussed not only the research program of the reactor division, but also the operating procedures of AEC contractors—a task it had not been assigned. The committee explained that it ventured beyond its "specific delegated responsibilities" to the reactor division and concerned itself with "all phases of ground disposal of radioactive wastes" because, "like all responsible citizens, the members of the Committee are concerned for the welfare of man and the perpetuation of an environment in which he can satisfy his physical needs and realize his cultural aspirations."<sup>9</sup>

The report was highly critical of the waste disposal practices at the major AEC installations. As Earl Cook, the group's executive secretary, later summarized the committee's conclusions: "It had become clear that (1) not one of those sites was chosen with safe waste disposal in mind; (2) not one of the sites has proved capability for safe disposal on site of all waste produced by the plant; and (3) compromises between safety (defined as isolation from the biosphere of all radioactive wastes during their hazard lives) and economic expediency had been and were still being made."<sup>10</sup>

When the committee sent a draft of its report to the sponsoring agency (a frequent practice among Academy commit-

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\*The committee was now chaired by John E. Galley, a consulting petroleum geologist from Texas. The other members were Charles W. Brown, a research geologist with Socony Mobil Oil Co.; George B. Maxey, research professor in hydrology and geology at the University of Nevada's Desert Research Institute; John C. Maxwell, chairman of the geology department at Princeton University; Charles Meyer, professor of geology at the University of California at Berkeley; Robert C. Scott, a water resources specialist with the U.S. Geological Survey; Charles V. Theis, research hydrologist with the U.S. Geological Survey; and A. F. Van Everdingen, a petroleum engineer with DeGolyer and MacNaughton, a Dallas, Texas, consulting firm. J. Hoover Mackin, chairman of the NRC Division of Earth Sciences in 1966, a geology professor at the University of Texas at Austin, was an ex officio member of the committee. Earl Cook, former director of the Idaho State Bureau of Mines, served as executive secretary.

tees), the AEC immediately tried to get the committee to delete its criticisms of the operating practices of AEC contractors.<sup>11</sup> But the committee unanimously refused to delete anything—it agreed only to recast its criticisms as background to recommendations for further research. The report was finally completed in May 1966; its text contained the harshest criticisms yet leveled at the AEC's waste management program.

The report reiterated the committee's continuing conviction that "none of the major sites at which radioactive wastes are being stored or disposed of is geologically suited for safe disposal of any manner of radioactive wastes other than very dilute, very low-level liquids."<sup>12</sup>

With respect to all of the ground-disposal procedures then in routine operation, the committee acknowledged that "no serious hazards" had been created "at present." But it expressed concern "about the long-term safety of the operations if they are to be continued at the same sites for many decades or even for centuries." The committee also faulted "the working philosophy of some operators, although certainly not that of the AEC, that safety and economy are factors of equal weight in radioactive-waste disposal." It noted that "lack of funds has been cited at one location or

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\*The only exception cited by the committee was a hydrofracture-and-grouting technique used to dispose of intermediate-level liquid wastes at Oak Ridge. The report found fault with waste disposal practices and plans at virtually every site. With respect to NRTS in Idaho, the committee expressed anxiety "that considerations of long-range safety are in some instances subordinated to regard for economy of operation" and that "some disposal practices are conditioned on over-confidence in the capacity of the local environment to contain vast quantities of radionuclides for indefinite periods without danger to the biosphere." With respect to Hanford, the committee expressed concern "over the prevailing belief" that the top layers of several hundred feet of soil, sand, and gravel would "provide a reservoir for safe storage of tremendous quantities of wastes of all levels of radioactivity, and that no hazardous amounts of radioactivity will percolate down to the water table." With respect to Savannah River, a majority of the committee argued that a plan to bury high-level wastes in bedrock deep beneath the site was "in its essence dangerous." And with respect to Oak Ridge, the committee reiterated its opposition to the use of seepage ponds. The committee was generally opposed to the existing practice of putting intermediate- and low-level liquid wastes as well as solid waste directly into the ground above fresh water zones. It acknowledged that such practices were "momentarily safe" but warned that they would "lead in the long run to a serious fouling of man's environment."

another for inability to conduct needed research or to use alternate disposal methods which are agreed to be safer than current practices." But it added: "It is apropos to point out that waste-disposal costs are now a small part of the overall expense budget of the nuclear industries, and that any compromise with safety for the sake of economy could lead, in the long run, to a mushrooming of waste disposal into the most costly item in the use of nuclear power."<sup>13</sup>

The report—the toughest attack on the waste disposal program yet issued—was transmitted to the AEC in May 1966; it promptly disappeared from sight for several years. On November 7, 1966, the AEC sent a fifteen-page critique to the Academy which purported to show that the committee's report had been misguided in its major conclusions and recommendations and inaccurate in various details. In a cover letter, the AEC said that, since the report had already been made available to pertinent personnel, "we do not believe that additional distribution or publication of the report is warranted."<sup>14</sup> So the report was suppressed. Its disturbing conclusions were made known only to a handful of insiders despite repeated efforts by the committee to get the document released. The committee prepared a rebuttal of the AEC's critique but this, too, was never made public.\*

What's more, the committee itself was disbanded. The

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\*The committee was not the only part of the Academy to express concern over AEC waste disposal practices. Even before the committee had completed its report, the Academy convened a separate ad hoc group headed by Academician Abel Wolman, professor of sanitary engineering at the Johns Hopkins University, which concluded:

Because the AEC is an operating agency, there has been a tendency to solve storage and disposal problems on an *ad hoc* basis. There is a need for a long-range, comprehensive plan that will elucidate the principles and practices needed to solve not only present problems but those of the future; the plan should take into account the possible effects of unusual natural events and disasters, as well as foreseeable man-related environmental changes; and it should reflect an awareness that expedient small-scale practices may be hazardous, particularly with respect to long-lived nuclides, if the practices continued to be carried on for a long period of time or on the enlarged scale expected to be reached in 1975. [Frederick Seitz to Glenn T. Seaborg, August 30, 1965.]

But the AEC brushed aside the Wolman group's concerns with a reply that contended the AEC already had matters well in hand (Glenn T. Seaborg to Frederick Seitz, November 1, 1965).

AEC, which had been funding the committee's work under contract, informed the Academy that it intended to end the advisory relationship as of mid-1967 "because a major part of our ground disposal R&D program is reaching a successful conclusion."<sup>14</sup> That meant that the committee could no longer function unless it found another source of support. The Academy made no effort to obtain additional support because, as then-President Seitz recalls, "It isn't easy to get support for a committee so obviously related to the work of any agency. . . . You'd have had to beat a lot of bushes."

The possibility that the AEC might cut itself off entirely from any independent advice alarmed the top leadership of the Academy. "Everything I have seen during recent years suggests to me that the geologic problems associated with radioactive waste disposal will grow rather than diminish in the period ahead," Seitz told the AEC. ". . . As a result I would have substantial hesitation about terminating the committee without assurances that the gap left would be appropriately filled."<sup>15</sup> Further meetings were held between Academy and AEC officials and a compromise was finally reached, though the price to the Academy was high. The original committee was dismissed, and a new committee was established with a virtual guarantee that the AEC would have closer control over its operations. A proposal submitted to the AEC by the Academy on February 29, 1968 (and accepted by the AEC on March 11, 1968), stated that membership of the new committee "shall be discussed with the AEC"—thus giving the agency an implied veto over the makeup of the committee. The proposal also said that committee reports would be furnished to the agency "for its consideration and any distribution beyond the AEC"—thus acknowledging that the AEC would retain the right to suppress reports that were not to its liking.<sup>16</sup> Finally, the new committee was placed in the NRC Division of Chemistry and Chemical Technology, a move which had the effect, intended or not, of putting it under the supervision of a division which had closer ties to the nuclear industry than did the earth sciences division under which the old committee had operated. The chairman-designate of the chemistry division at the time the committee was formed was an executive of the DuPont Company, which operates the AEC's Savannah River Plant; one of the members of the division's executive committee was a vice-president of the General Electric Com-

pany, which had operated the AEC's Hanford plant from 1946 to 1966 and which was building a nuclear fuel reprocessing plant that would generate high-level wastes.

Thus the AEC had gained a more controlled advisory relationship under the new set-up. The only real gain to the Academy was that the new committee—called the Committee on Radioactive Waste Management—would have a broader mandate than the old. It would advise the agency as a whole, not just the reactor division. And it would deal with the broad issue of waste disposal, not just the geologic aspects of the problem. Moreover, it would be concerned with operational matters, in addition to the research aspects which were supposed to be the main focus of the previous committee.

Nevertheless, the circumstances suggest that the AEC emerged with the upper hand. The new committee was loaded with scientists who had close ties to the AEC or its major contractors. The committee's first chairman was Clark Goodman, head of the physics department at the University of Houston, who had formerly served as assistant director of the AEC's reactor division, the very division which had been at war with the previous committee. The new committee also included a former deputy director of that same division; a former manager of the AEC's Hanford Laboratories; a former atomic energy official of the DuPont Company, which operates the AEC's Savannah River plant; and a former deputy director of the AEC's Brookhaven National Laboratory. The four remaining members, although based at universities or state agencies, had ties with the AEC ranging from long-term consulting arrangements to a brief period spent as a visiting scientist at an AEC installation.\*

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\*The members of the committee, in addition to Goodman, included: Robley D. Evans, Massachusetts Institute of Technology, a longtime consultant to the AEC; John C. Frye, chief of the Illinois State Geological Survey, a member of the health physics advisory committee of the AEC's Oak Ridge National Laboratory; Jack E. McKee, California Institute of Technology, a member of the AEC's Advisory Committee on Reactor Safeguards; Herbert M. Parker, Battelle Memorial Institute, former manager of the AEC's Hanford Laboratories; Louis H. Roddis, Jr., General Public Utilities Corporation, former deputy director of the AEC's reactor development division; John H. Rust, University of Chicago, who had spent a year as a visiting scientist at Oak Ridge; Clarke Williams, former deputy director of the

In contrast to the cozy relationships between the new committee and the AEC, the previous committee had had very few members who were close to the agency, partly because it was composed of geologists and the AEC has never had much expertise in geology, partly because it strove to remain independent. In fact, Hubbert, when he became chairman of the NRC earth sciences division in 1963, made a point of dropping one member of the old committee, the late William B. Heroy, after it became known that a consulting firm with which he was associated had a contract to advise the AEC on waste disposal in salt.

Although the AEC seemingly had a profound influence over the committee in its formative years, that influence has since slackened. Academy officials insist that the AEC no longer has the right to suppress Academy reports; they say the Academy itself now decides whether a report will be made public.

The complexion of the committee has also changed over the years so that now it is less blatantly loaded with former AEC officials. But an AEC flavor remains. Of the twelve members of the committee during 1972-73, five had once held key positions with the AEC, its laboratories, or its industrial contractors,\* while some of the others are said to

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AEC's Brookhaven National Laboratory; and Hood Worthington, consulting nuclear engineer, who had served as an atomic energy executive for the DuPont Company, which operates the AEC's Savannah River Plant, and who had served on AEC advisory panels. The staff man for the committee was Cyrus Klingsberg, who had worked for the Office of Naval Research before coming to the Academy. The AEC's liaison man was initially John A. Erlewine, who was then assistant general manager of the agency.

These ties may be but the tip of the iceberg. Since an agency's grants, contracts, and consulting arrangements are seldom publicized widely, it is difficult to ascertain what relationships exist between a given scientist and a given agency.

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\*The five are W. Kenneth Davis, vice-president of the Bechtel Corp., former director of the AEC's reactor division and former president of the Atomic Industrial forum; Herbert M. Parker, consultant and former manager of the AEC's Hanford Laboratories; F. H. Spedding, former director of the AEC's Ames Laboratory at Iowa State University; Clarke Williams, former deputy director of the AEC's Brookhaven National Laboratory; and Warren F. Witzig, head of the nuclear engineering department at Pennsylvania State University, who has held positions in the nuclear industry and at the AEC's Bettis Laboratory.

have received AEC financial support for their research projects.

The new committee has issued three reports since it was formed in 1968. Each has been supportive of the AEC although none can be described as a complete whitewash.

The first, produced in February 1970, was labeled an "interim report." It is a skimpy nine-page document which is of interest primarily because it served the AEC's political purposes so well. Late in 1969 the AEC came under pressure to release the Academy's 1966 report that had been so critical of AEC waste disposal practices. On October 7, 1969, Senator Frank Church (D-Idaho), whose home state includes the AEC's National Reactor Testing Station, informed the agency he knew of the existence of the report and asked why it had not been made public. In reply AEC Chairman Glenn T. Seaborg implied the previous committee had made numerous errors and had therefore been replaced with a more competent committee by the Academy.<sup>17</sup> (He neglected to mention that the previous committee was dissolved only because the AEC had cut off its funding.) This new "broader" committee would prepare a report of its own, Seaborg promised. But Church was not satisfied. And in March 1970, Senator Edmund Muskie (D-Maine), whose subcommittee on air and water pollution was holding hearings on underground uses of nuclear energy, formally asked the AEC for a copy of the 1966 report.<sup>18</sup> At that point, the AEC gave in. The agency made the report available to the press and explained that it had not really "suppressed" the report; it had simply not published it (conveniently forgetting that it had also not allowed the Academy to publish it).<sup>19</sup> Once again, the AEC promised that the new committee, with its "broader spectrum of scientific disciplines," would be reporting its impressions soon.<sup>20</sup>

It is not surprising that the new committee's "interim report" gave the AEC what it needed. The report was little more than a long list of everything the committee had done in its first two years—meetings held, AEC sites visited, and topics discussed. But it contained one value judgment which seemed to run counter to the findings of the previous Academy committee. "The Committee noted the extensiveness and care in waste management at each site visited," the interim report said. "The Committee is gratified by the qual-

ity and scope of the R&D program sponsored by the AEC in radioactive waste management."<sup>21</sup> The AEC submitted the interim report to the Muskie subcommittee along with the suppressed 1966 report. Thus the AEC had managed to use the new committee to blunt the criticisms raised by the old.

The new committee's second report, entitled *Disposal of Solid Radioactive Wastes in Bedded Salt Deposits*, proved to be a minor embarrassment to the Academy. It was published in November 1970 after a hectic last-minute flurry of rewriting. The committee had originally been asked to review the general concept of burying wastes in bedded salt. As noted above, the previous Academy committee had first suggested burial in salt, though it had not specified what types of salt formation should be used. Subsequent studies conducted by Oak Ridge National Laboratory, with periodic advice and encouragement from the previous Academy committee, had indicated that bedded salt (long horizontal layers) would be preferable to salt domes (narrow vertical formations) and that the liquid wastes could be solidified before burial, thus reducing the possibility that the wastes would migrate from the burial spot. After the previous Academy committee had been dismissed, Oak Ridge had further developed the technology and plans for salt burial, so the new committee was asked to review the concept once again before the AEC progressed further with the project. A panel of experts appointed by the committee visited Oak Ridge in May 1970 and held a meeting in Lawrence, Kansas, in June (Kansas has extensive salt deposits and had been the site of several Oak Ridge experiments). The panel was actually working on the second draft of a report reaffirming the salt concept and was in the midst of its meeting in Lawrence when the AEC pulled a surprise. John A. Erlewine, assistant general manager of the AEC, held a press conference in Topeka and announced the "tentative selection" of a salt mine near Lyons, Kansas, as the site for a project to demonstrate the feasibility of burying radioactive wastes.<sup>22</sup> The mine had long been discussed as a possible national repository for wastes generated by the commercial nuclear industry and, if necessary, for AEC-generated wastes as well. Erlewine was the AEC's officially designated liaison to the Academy committee, but he had not told the committee of

the agency's latest plans. The announcement caused consternation on the panel, which felt it could not very well come out months later with a report that discussed salt but made no mention of the AEC's specific plans. So the panel tried to shift its focus late in the game. As Frye, who was a member of the panel as well as chairman of the parent committee, explained in an interview: "We started out considering the general concept of bedded salt and then, kind of at the last minute, tried to focus it on one site because the AEC said 'That's where we're gonna go.'"

The panel revised its report, and the parent committee then rewrote the revision substantially. As finally published, the report had two major conclusions:

1. The use of bedded salt is "satisfactory" and, in fact, is "the safest choice now available, provided the wastes are in an appropriate form and the salt beds meet the necessary design and geological criteria."

2. "The site near Lyons, Kansas, selected by the AEC is satisfactory, subject to the development of certain additional confirmatory data and evaluation."<sup>23</sup>

The report was not an all-out endorsement of the Lyons site. It suggested a number of studies that should be completed before any radioactive materials were actually committed to the salt beds and, like many Academy reports, it included numerous caveats—in this case, to cover the committee's flanks should the site prove a bad choice. But the tone of the report suggested that the Lyons mine was suitable and that the additional studies would not constitute a serious impediment to proceeding with actual burial. As the report expressed it, "Based on research and development performed to date the Committee does not anticipate any insurmountable problem."<sup>24</sup>

Proponents of the Lyons site welcomed the Academy report as an endorsement of their views. Milton Shaw, director of the AEC's Division of Reactor Development and Technology, asserted in Congressional testimony that the site "had been recommended" by the Academy.<sup>25</sup> And Chet Hollifield (D-California), a strong supporter of the AEC, triumphantly told a critic of the site: "The Committee on Radioactive Waste Management of the National Academy o.

Sciences said to go ahead. You heard here the two recommendations they made. You heard them the same as I did."<sup>26</sup>

The Academy report would apparently have been even more enthusiastic about the Lyons site had it not been for the influence of a single member of the panel, William W. Hambleton, director of the Kansas Geological Survey. Hambleton had been appointed to the panel after he had recommended to the governor of Kansas that site selection for the waste repository be deferred pending further studies to demonstrate the integrity of the Lyons mine. Hambleton and the Survey became the focal point of scientific opposition to the AEC's plans. They did not flatly reject the Lyons site, but argued that the safety of salt in general and of the Lyons site in particular had not been adequately established. Hambleton issued a series of reports in Kansas criticizing the AEC for its failure to conduct various studies he felt were needed. Meanwhile, he lobbied intensively to persuade the Academy panel to raise questions about Lyons.

As it turned out, the Lyons site was not suitable. In September 1971 the AEC revealed that two unexpected discoveries cast doubt on the feasibility of using the Lyons mine. One discovery, which resulted from a survey conducted by a consultant hired by Oak Ridge, was that there are at least twenty-nine abandoned gas and oil drillholes which extend into or below the salt formation near the site. The consultant concluded that, while twenty-six of these could probably be plugged successfully, the likelihood of plugging the other three was "very low."<sup>27</sup> Thus the possibility was raised that water could leak from these abandoned holes into the Lyons mine, destroying its integrity. The second discovery was that an adjacent salt mine, operated by the American Salt Company, had made extensive use of "solution mining," a technique in which water is used to dissolve the salt. Such mining leaves no supporting pillars underground, thus introducing what the AEC called a "potential for sudden and dramatic collapse of a fairly large area not too far from the Repository site, with the formation of a surface lake which could be several hundred feet deep." The AEC claimed such a lake would probably have "no real technical significance to Repository safety" but said its formation "could certainly engender unfavorable emotional and public relations problems." The situation was complicated by the

fact that American Salt had once used a hydraulic fracturing technique in which water is forced down one hole where it cracks the salt bed and then works its way over to a second hole and returns to the surface carrying dissolved salt. American Salt tried the technique once in the mid-1960s. It worked well for a brief period, but then some 175,000 gallons of water suddenly disappeared. Neither the company nor the AEC knows where it went. Thus the possibility exists that the missing water, and other water from the solution mining as well, could be migrating toward the proposed waste disposal site. To make matters worse, American Salt revealed that it planned to double its solution mining activities.

The sudden revelations forced the AEC to announce that, pending further study, "We are holding in abeyance any further site oriented work at Lyons, including leasing of land and plugging of holes."<sup>28</sup> The AEC promptly asked the Kansas Geological Survey and the Oak Ridge drilling consultant to search available records for other possible sites. The results of that survey were made public on January 21, 1972. Of eight areas considered, three were judged to have potential worth investigation, four were deemed less promising, and the area which included Lyons was deemed "the poorest candidate" of all, largely because it has numerous old oil and gas holes, a large number of producing wells, water above and below the salt, possible deep-seated structural problems, inadequate buffer zones, and high potential for development of oil and gas reserves in the future.<sup>29</sup> The setback at Lyons forced the AEC to announce, in May 1972, that it planned to build engineered surface facilities to store high-level wastes produced by the nuclear power industry.<sup>30</sup> Such facilities would give the AEC an alternative should no suitable geologic repository be found. Meanwhile, the AEC said it would also search for suitable locations in salt and other geological formations outside Kansas and would explore longer-range concepts such as disposal in space, disposal under the polar ice caps or the sea bed, and conversion of the toxic material by nuclear processes called transmutation.<sup>31</sup>

The Academy report did have the foresight to recommend that a survey be made of oil and gas wells in the surrounding area, but made no mention whatever of solution mining.

Why didn't the committee itself envisage the problems at Lyons? A number of factors probably conspired to lull the Academy into endorsing the AEC's plans. The last-minute change of focus, in which the panel suddenly decided to discuss Lyons as an afterthought, virtually guaranteed that the discussion would be superficial rather than a full-scale site analysis. The AEC orientation of some members of the parent committee, which rewrote the panel's report substantially, may have influenced the report's optimistic tone. The Academy's long-standing support for the use of salt beds may have made the panel a bit too eager to get on with an actual demonstration project. And the part-time nature of Academy committee work made the Academy largely dependent on the information supplied by others. If the committee had known about the numerous drill holes and the solution mining, it would presumably have been more skeptical of the Lyons site. But it was not apt to uncover such information independently. "Anybody's got rocks in their head if they expect guys working for no salary to do the kind of job Bob Walters [the Oak Ridge consultant who found all the drill holes] did on a damn good retainer," says John Frye, Academy panel chairman.

The difficulties that arose at Lyons led Senator Mike Gravel (D-Alaska), a frequent critic of the AEC, to complain that "The failure of both the AEC's final environmental [impact] statement and the National Academy of Sciences review to disclose such serious problems at Lyons, Kansas, raises a mammoth question. What good is [an impact] statement, or a NAS review?"<sup>32</sup> Academy officials consider that phraseology overly harsh. "Gravel's a horse's ass," says Klingsberg. "I think the Academy and this committee covered themselves professionally with great distinction." But the circumstances surrounding this particular report suggest that Gravel may be essentially correct: The committee seemed just a bit too willing to endorse an AEC plan which had not been adequately researched.

The committee's third report, published in early 1972, was an evaluation of a plan to store high-level wastes in caverns mined in the bedrock beneath the Savannah River Plant in South Carolina. The plan had first been proposed to the AEC in 1959 by the DuPont Company, which operates Savannah River under contract; it had been under continuous investi-

gation ever since. The high-level wastes generated at Savannah River thus far (largely as a byproduct of weapons work) have been stored in underground tanks, but this is considered only an interim solution until a more permanent disposal site can be found.

The previous committee had been cool to the bedrock concept from the start. Hubbert recalls that the previous committee objected that the bedrock would inevitably be criss-crossed by joints and fractures which would allow the wastes to leak out, thus endangering the Tuscaloosa aquifer, a major source of drinking water for much of South Carolina and adjacent parts of Georgia. The water-bearing Tuscaloosa Formation lies directly beneath the Savannah River Plant and directly above the bedrock into which the wastes would be deposited. Another concern was that the wastes might migrate to the nearby Savannah River.

The committee had considered the bedrock proposal in some detail in its 1966 report, which was suppressed. At that time a majority of the committee concluded that the plan was so inherently hazardous that all further work on the project should be stopped. "The placement of high-level wastes 500 to 1,000 feet below a very prolific and much-used aquifer is in its essence dangerous and will certainly lead to public controversy," the majority said. "Any demonstration of safety must leave no shadow of doubt." The majority concluded that "apparently, the only safe disposal for high-level wastes would be an offsite disposal, presumably involving solidification before transportation." However, a minority of the committee recommended that work continue and that various steps be taken to further test the concept.<sup>33</sup>

The AEC chose to ignore the majority opinion and instead followed the minority recommendations. As the agency later explained, "Even with an assumed poor probability of carrying the bedrock program to completion, the potential savings in public funds was estimated to be so great that continuing the program to a definite end, one way or the other, seemed warranted." The AEC estimated that it would cost \$500 million to solidify the wastes and ship them to an offsite repository for permanent storage, compared with only \$80 million to put them in the bedrock. Meanwhile, the DuPont Company, dissatisfied with the Academy's report, had appointed its own panel of scientific consultants. They

reported in May 1969 that the bedrock concept was sufficiently promising to warrant construction of an access shaft and several exploratory tunnels. Such tunnels were essential to disclose the extent of fissures and fractures in the bedrock, the DuPont panel said. "The probabilities of producing evidence to warrant the completion of the entire project are high."<sup>34</sup>

That was where matters stood when the new Academy committee was asked in early 1971 to review all previous reports and all newly acquired data. The committee appointed a panel which interviewed project officials as well as critics from the previous Academy committee. In early 1972 the new committee published a report which concluded that there is "a reasonable prospect" that wastes can be stored in the bedrock and kept isolated from the biosphere for at least a thousand years. The panel concluded that no reasonable amount of exploration from the surface could conclusively demonstrate the safety of the concept, so it recommended that an exploratory shaft and tunnels be sunk. But the report warned that, if data from these explorations did not "clearly confirm" the safety of the project, then the concept "would become invalid."<sup>35</sup>

The new Academy committee had thus disagreed with the majority on the old committee, which had recommended dropping all further investigation of the bedrock concept. The disagreement stemmed partly from the use of different assumptions and calculations to determine how fast the waste is apt to migrate from the burial spot, partly from the fact that the new committee was looking at more recent information, and partly from differing assessments of the AEC's intentions. The old committee feared that the AEC would make a decision based primarily on economics without due regard for public safety. It did not really oppose exploratory tunnels per se but rather feared that such tunnels would simply increase the momentum behind a project it regarded as inherently dangerous.

The new committee, on the other hand, is less suspicious of the AEC. Klingsberg is satisfied that "the social conscience of the AEC is first-rate." And he believes that, if the AEC tried to go ahead with something dangerous, the Academy could always block it. "If the Academy committee can build up pressure to go ahead," he says, "then the Academy

committee can build up a hell of a lot of pressure to stop it." Maybe so, but the performance of the committee to date suggests that it would tend to go along with the AEC in the absence of overwhelming evidence to the contrary.

However, on November 17, 1972, the AEC itself had second thoughts. Faced with budgetary problems, political opposition in South Carolina, and the realization that it would require "considerable additional investigation" to demonstrate the safety of disposal in the bedrock, the AEC announced that it would "indefinitely postpone further development of the bedrock project" and would place priority on "other disposal methods."<sup>36</sup>

The story of the radioactive waste committees highlights a dilemma that continually confronts the Academy: How can a committee maintain a long-term advisory relationship with an agency, a relationship which depends on mutual trust and agency funding, and yet remain independent, even critical, in viewpoint? The old committee tried to adopt the role of independent gadfly. It successfully pushed the salt concept, but then it became, in AEC eyes, a bothersome nuisance when it repeatedly charged that none of the AEC plant sites was suitable for waste disposal. The AEC disagreed, and it exercised its prerogative of ignoring the advice. The committee waged its campaign vigorously behind the scenes, but its nagging did little more than anger the AEC—for, while the committee itself was willing to challenge the AEC publicly, the Academy leadership at the time was not. When conflict arose over the 1966 report, President Seitz chose not to make an issue over the disagreement. Instead, he bargained for a compromise that would allow the Academy to continue operating as a close adviser within the AEC orbit. Unfortunately the new committee which emerged from that compromise abandoned the gadfly role. It drew many of its members from among scientists who are close to the AEC. And it acted more like a consultant serving a client than like an independent critic. The new committee is by no means unwilling to raise questions about AEC projects, but it does so as a family adviser, not as a disinterested examiner.

This approach has its advantages. Klingsberg says the AEC is now more willing to listen to what the Academy says

and that the exchange of information between the two organizations is smoother. Moreover, the AEC says it has benefited greatly from the committee's advice.

But the approach also has its drawbacks. For one thing, advisers who get too close to an agency find it difficult to adopt the probing, aggressive stance that is often needed to expose weaknesses in an agency's plans. Almost all the expertise on radioactive waste disposal lies in the hands of the AEC or its contractors, a circumstance which makes it particularly important to have a truly independent scientific assessment, even an adversary assessment, of AEC programs. In the case of Lyons, the Kansas Geological Survey adopted an adversary role. But in the case of Savannah River there has been no organized outside scientific assessment, either independent or adversary. The Academy, in theory, is supposed to supply an independent judgment. But the new committee's performance thus far—its production of an interim report which helped the AEC blunt the criticisms of the suppressed 1966 report, its willing endorsement of the Lyons site, and its support of bedrock exploration which the previous committee had condemned—all these suggest that the Academy is acting more as an accessory to AEC plans than as a hard-nosed guardian of the public interest.

The committee has also found it difficult to exert influence on matters the agency doesn't want discussed. It is generally agreed, for example, that the AEC has not put enough effort into solving the waste disposal problem. Two reports by the General Accounting Office in 1968 and 1971 attest to this.<sup>37</sup> The old committee tried to goad the AEC into devoting greater resources to the problem. Indeed, the old committee ran into trouble with the AEC because it exceeded its mandate and tried to comment on the AEC's whole approach to waste disposal. But the new committee does not consider this its job. "You really can't tell them what they should do except in a specific context," says Frye, "because if you say, 'Look—you're not putting enough effort into waste management in general,' they'll say 'Who the hell asked you?' and with some justification."

That statement underlines the subservience of the Academy's position and the timidity of its attitude. The new committee has done little more than comment on the feasi-

bility of plans for specific projects—projects that were generally well developed before the committee's advice was even sought. It has never attempted a comprehensive review of the radioactive waste problem or of the AEC's program to cope with it. Nor has it compared the risks and benefits of burying wastes at one proposed site with the risks and benefits of disposing of the waste by other means. The AEC is supported by public funds. If it needs more funds for "safe" disposal, or if waste hazards threaten the expansion of nuclear power, then the public should be informed of the risks and Congress should debate the problem extensively. Unfortunately, the Academy, *the only technical group outside the AEC which has maintained continuing surveillance over the program*, has done little to raise the pertinent issues. One suspects that the AEC would be further along toward solution of the waste disposal problem if the Academy had found some way to alert the public to the magnitude of the problem and the inadequacy of the attention being paid to it.

The Academy has made genuine efforts in recent years to increase the committee's independence. It has added members who have no ties to the AEC. And, in early 1973, it placed the committee under the jurisdiction of the Environmental Studies Board, a move which should increase the committee's sensitivity to the environmental hazards of waste disposal. But these steps are merely palliatives. A key lesson to emerge from our examination of this committee is that the Academy's part-time advisory apparatus is not strong enough to keep effective watch over an agency whose operations involve incalculable risks to future populations. The nation needs a full-time, government-sponsored monitoring group of highly qualified scientists, totally independent of AEC funding and influence. Part-timers, unpaid, relying on the AEC for data, dependent on the AEC for funds, just cannot do the job.\*

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\*In early 1975, the AEC's nuclear development activities, including its waste management programs, were to be merged into a new Energy Research and Development Administration, responsible for all forms of energy, not just nuclear. Such an administrative reshuffling would not obviate the need for independent monitoring, for the AEC was expected to form the core of the new agency, its promotional instincts intact.