

APPENDIX H
HISTORY OF REVIEWS OF THE LONG-RANGE
WASTE MANAGEMENT PROGRAM AT SRP

The long-range waste management program at the Savannah River Plant (SRP) has had the benefit of reviews and recommendations by consultants and independent organizations. A short history of these reviews and the program decisions that were made based on them is presented here.

NAS

From 1955 to 1965, the Committee on Geologic Aspects of Radioactive Waste Disposal of the National Academy of Sciences - National Research Council (NAS-NRC) served as advisor to the Division of Reactor Development and Technology of the U.S. Atomic Energy Commission. The Committee's responsibility to that Division was to observe and study critically the research and development activities of the Division with respect to radioactive waste disposals in the ground, and to provide counsel regarding the safety of the Division's current and proposed operations insofar as they are affected by geologic considerations.

Although its specific delegated responsibilities were the geologic aspects of the research and development program of the AEC's Division of Reactor Development and Technology, the Committee concerned itself with all phases of ground disposal of radioactive wastes and drew conclusions on overall waste management practices.

The Committee consisted of eight members which changed from time to time as earlier members were replaced by new ones. For the four meetings that concerned SRP, only one member was on the Committee continuously, and five were appointed just prior to the last meeting in 1965. Reference 1 shows the attendance and membership of the Committee for the four meetings that involved SRP.

In September 1955, a conference was held at Princeton University at which 65 scientists representing many branches of earth sciences, biology and medicine, chemistry, physics, engineering, and other pertinent fields of knowledge considered various problems of radioactive waste disposal on land and offered suggestions toward their solution. The primary proposed disposal methods which developed

from this meeting were disposal in salt, deep-well disposal in permeable formations, and conversion of liquid wastes to solids. Although this conference did not directly involve SRP, it set the stage for later conclusions by the Committee about proposed SRP waste storage programs.

In March 1960, the Committee met to consider a proposal to investigate the safety and feasibility of storing radioactive waste in facilities excavated in bedrock beneath the plant site. The Committee recommended that SRP proceed with test borings, and that the project then be reconsidered after the results of the tests were available. In addition, AEC asked the U.S. Geological Survey, the U.S. Bureau of Mines and the U.S. Army Corps of Engineers to assist in the design of the investigation in a consulting capacity.

In December 1961, after one test well was complete and three others started, the NAS-NRC Committee met at the Savannah River Plant to review the progress of the investigations and to make specific suggestions on the direction of the exploratory boring program. The minutes of this meeting are given in Reference 2.

The drilling and testing program for bedrock storage was finished in December 1962, and the results were included in an AEC report that was published in 1964 (DP-844, Reference 3). The conclusion of this report was that storage of liquid radioactive wastes in excavated chambers was technically feasible. No further investigative program was outlined.

In June 1963, the NAS-NRC Committee met in Washington, D.C., to review bedrock storage. They concluded that for long-term safety, underground disposal at this locality is much better than storage in surface tanks, and that work be started on the next phase of the program. The Committee expressed concern that the hydrologic disturbance caused by the exploration drilling may have invalidated some of the hydrologic tests, and recommended that hydrologic observations should be continued until a state of equilibrium could be conclusively established. The Committee's review is given in Reference 4.

From 1964 through 1966, the U.S. Geological Survey carried on numerous hydrologic tests in the already existing bedrock exploration holes.

On April 12-13, 1965, the Committee with a different membership visited the Savannah River Plant to review the status of the bedrock waste storage project which had been carried on at a very low level during the intervening two years. This visit was one of an itinerary in which all of the major AEC production sites were visited to review their research and development programs on radioactive waste disposal to the ground.

The reviews and recommendations resulting from these visits are contained in a report to the Division of Reactor Development and Technology dated May 1966.⁵ In regard to the bedrock waste storage exploration at the Savannah River Plant, a majority of the Committee recommended that the program be discontinued but a minority recommended that the program continue, outlining specific lines of investigation that should be pursued. Most of the Committee additionally recommended that high-level waste not be stored above freshwater aquifers. After much consideration of the recommendations as well as alternative programs for long-term containment of waste, the AEC decided to pursue the program outlined by the minority of the Committee. Comments on this report are contained in a letter from the Director of the Division of Reactor Development and Technology to the President of the National Academy of Sciences.⁶ After the issuance of its report in May 1966, the Committee on Geologic Aspects of Radioactive Waste Disposal, NAS-NRC went out of existence.

GAO

In May 1968, the General Accounting Office reported on a review of high-level radioactive waste management. After reviewing conditions and programs at each site where high-level waste storage exists, GAO concluded that AEC needed to devote more vigorous attention to advancing the technology required to permit long-term storage at the Richland and Savannah River sites. This report is Reference 7. As a result of this report, SRP began a study of the Triassic bedrock nearer the Savannah River, and employed a consulting firm to independently review bedrock storage, and to develop concepts for the storage vault.

In January 1971, the General Accounting Office again reviewed the high-level radioactive waste management programs of AEC and concluded in its report:⁸ "Although AEC has assigned a high priority to radioactive waste management problems, GAO believes that the level of effort given to these programs should be increased in view of their extraordinarily complex characteristics. The problems and delays being experienced are attributable primarily to a need for more definitive technology on such matters as the relative merits of alternative practices and proposals for interim and long-term storage."

S. C. LEGISLATURE

In May 1971, the South Carolina State Legislature adopted a resolution establishing a "committee to study the establishment of plants or facilities for the recovery of nuclear fuel and the storage of waste nuclear materials." A report on its findings was

published in 1972.⁹ One of the recommendations of the committee was "that South Carolina authorities oppose ultimate permanent storage of high-level radioactive waste in South Carolina because testimony given this committee up to this point in time indicates there are other more suitable locations for such storage."

CONSULTANT PANEL

In the fall of 1968, Du Pont convened a panel of six consultants in the fields of geology, hydrology, geochemistry, civil engineering to review bedrock storage and all of the work to date, then to advise on the direction of the program. If the Panel recommended continuance, they were also expected to provide overall directions to the program. The Panel concluded in a May 1969 report:¹⁰ "As a result of all these deliberations, the Panel is of the judgment that the bedrock storage proposal has sufficient promise of offering a permanent solution to a critical waste handling problem to warrant a major step forward in construction. At the same time, the explorations which have taken place over the past years make clear that a definitive assurance that bedrock storage would provide complete and permanent safety to the public can only be provided by the actual construction of the shaft and several of the tunnels. Such a procedure is essential to disclose the number and degree of fissures or fractures which will be encountered, in fact, at the depth under consideration. The Panel strongly recommends, therefore, the construction of the shaft and appropriate tunnels."

During the period 1969 to 1971, additional information became available on the Triassic rock, a low porosity sandstone-claystone, that was known to exist in the southeast one-third of the plant site. This rock is extremely impermeable and did not evidence any fractures, which were a source of concern in the crystalline metamorphic rock due to the difficulty of mapping them using test wells. The Du Pont consulting panel suggested that more exploration be done on the Triassic rock and reviewed the existing information in a progress report dated December 10, 1971.¹¹ After this information had been developed, the most suitable host rock would be selected for further exploration with a shaft and test tunnels.

NAS

In March 1968, a Committee on Radioactive Waste Management was created by NAS-NRC to advise the Atomic Energy Commission, rather than only one division of AEC, on long-range radioactive waste management plans and programs. This committee met at SRP only once, in January 1969. However, this committee sponsored a Panel on Bedrock Disposal to review that program specifically; their report is summarized below:

The highly radioactive wastes aged in tanks at the Savannah River Plant (SRP) site must ultimately be transferred to some facility that offers effective retention for centuries. A solution under consideration is to store these wastes in vaults in the rocks deep beneath the site.

For such long-term retention of radioactive wastes, an unprecedented degree of precise information is needed on the hydrologic systems in the bedrock, on the regional stress fields, on the structural integrity of mined openings, and on the chemical compatibility between the wastes and potential host rocks. It is also apparent that this needed degree of precision cannot be adequately obtained by exploration from the surface supplemented by a limited number of borings. This statement in no way diminishes the usefulness of the exploration from the surface, the chemical and physical tests, borings, and hydrologic calculations so far made. It reflects, rather, the fact that the metamorphic basement rocks, and the sedimentary rocks of Triassic age underlying the site, are neither uniform nor homogeneous and cannot be evaluated with precision from limited samples. The information acquired to date indicates a potential for a safe storage facility, but, in view of the intensity of the radioactivity of the material to be stored and the length of time required, the only prudent course is thorough exploration before final decision. The recently acquired data on the sedimentary rocks of Triassic age are encouraging and emphasize the need for complete exploration.

Information from in situ exploration of the potential host rocks will be essential for development of an environmental-impact statement. Such in situ exploration is possible only by the construction of a shaft to the proposed depth and the excavation of tunnels.

The proposed shaft and tunnels would serve several purposes. First, and most critical, such exploratory excavations would permit the examination and study of the host rock throughout the extent of the proposed vaults. Extrapolation of rock conditions from the walls of a small tunnel to a full-sized vault is reasonably certain, in contrast to the less certain extrapolation of rock conditions from borings hundreds of

feet apart. Also, it will be possible to make chemical and physical analyses of the rock throughout the entire dimension of the proposed vaults. Further, before the final decision is made to develop a full-scale storage facility, exploratory excavations will make possible observation of water movement in the host rock over a significant period. In addition, digging an exploratory shaft would identify the problems of engineering design and construction in penetrating the highly permeable water-bearing Tuscaloosa Formation that overlies the basement rocks. Because this is a primary regional aquifer, there must be assurance that a watertight shaft can be constructed through it and can be maintained.

The decision as to whether the exploratory shaft should be located in the metamorphic rocks or in the Triassic sedimentary rocks will depend on results of geological, geophysical, and geochemical investigations yet to be completed. Preliminary data suggest that the Triassic rocks are not extensively fractured, but the presence and spacing of joints and faults would be disclosed by the lateral tunnels. The physical, chemical, and engineering properties of the Triassic rocks are not adequately known, and exploratory excavations would facilitate their thorough study. If data from the exploratory shaft and tunnels do not clearly confirm that use of excavated vaults is safe for long-term isolation of SRP wastes from the biosphere, the concept as herein defined would become invalid.

[K.3] The Committee on Radioactive Waste Management reviewed the report of the Panel on Bedrock Disposal and endorsed the following conclusions and recommendations:¹²

1. The Panel on Bedrock Disposal has reviewed the pertinent information on management of high-level radioactive wastes now stored in tanks at the Savannah River Plant site. It concludes that the current interim procedure of tank storage is acceptable for short-term containment but is not acceptable over the hazardous radioactive life of the wastes.

The Panel recommends that efforts toward development of permanent storage facilities be continued.

2. The Panel has reviewed alternative methods of radioactive waste processing and storage.

Whatever method is adopted, the Panel recommends that it be capable of protecting the biosphere from these wastes for not less than 1,000 years.

3. The Panel concludes that there is a reasonable prospect of achieving such protection by storing the wastes in vaults in rocks underlying the Tuscaloosa Formation beneath the Savannah River Plant site. This conclusion refers only to wastes that have been aged a minimum of 10 years. The under-

lying rocks include two major kinds, Triassic sedimentary rocks and older metamorphic rocks; safe storage may be possible in either one.

To guide underground exploration and permit a choice between the Triassic sedimentary rocks and the metamorphic rocks, the Panel recommends additional field and laboratory investigations. These investigations must produce definitive information as to the three-dimensional characteristics of the two rock units that underlie the prolific, water-bearing Tuscaloosa formation. Particularly important is information on (a) the fluid transmissivity of different parts of the two rock units, (b) the hydraulic gradients within the rocks of Triassic age, (c) the ion-exchange capacities of the two units, (d) the chemical reactions between the waste and the potential host rock, and (e) the regional stress fields in the two units.

4. The Panel concludes that no reasonable amount of exploration from the land surface can conclusively demonstrate the safety of waste storage in deep vaults. Essential for such a demonstration is *in situ* inspection and testing of the rocks in which vaults might be constructed.

Accordingly, the Panel further recommends that an exploratory shaft be sunk and exploratory tunnels be driven in the rock selected.

5. The recommended experimental program is intended to develop the information that would permit an orderly analysis of all factors relevant to safety and environmental considerations.

The Panel recommends that a systematic framework for accumulation of the required data be established in conjunction with the design of an exploratory shaft and tunnels.

6. Study of the recommended exploratory shaft and tunnels may indicate that the proposed deep vault storage at SRP would not be acceptable. Since some long-term alternative to tank storage is needed, concurrent research and development of alternative waste-management procedures are necessary.

The Panel recommends that the U.S. Atomic Energy Commission continue vigorously to investigate alternative methods of fixing and storing wastes.

7. Study of the recommended exploratory shaft and tunnels may indicate that the proposed deep vault storage at the SRP is acceptable.

In this case, the Panel recommends that a competent and impartial review be made of this additional information before the decision is made to charge the vault with waste.

BEDROCK EXPLORATIONS

Based on the recommendations of the Du Pont Consulting Panel, which were later concurred in by the NAS-NRC Panel, that the next step of exploration was the construction of an exploratory shaft and tunnel, a consultant architect-engineering firm was retained. Realizing that this storage facility, if constructed, would have requirements beyond that of ordinary rock tunnels the consulting architect-engineer was asked first to make a broad scope review of all of the information so far developed for an additional expert opinion on the feasibility and safety of the project.

This preliminary study of available data^{13,14} concluded that the probability of the feasibility of the concept of storing radioactive wastes in bedrock tunnels is enough to warrant continuation of programmed and recommended studies of hydrology, rock mechanics, chemistry, and thermal considerations. It also concluded that "with data from "above ground" studies only, it will not be possible to state conclusively that the overall project objective is feasible. The host rock must be penetrated with man-sized exploratory shafts in order to permit detailed inspection and in situ testing. Only after conducting, analyzing, and synthesizing the results of such in situ investigations will it be possible to reach a definitive conclusion."

Two other reports were produced by the consultant architect-engineering firm^{15,16} on specific technical aspects of the program - deep shaft studies and the results of Triassic Exploration Drilling.

In November 1972, active investigation of bedrock storage of radioactive waste was indefinitely postponed while major effort was turned toward alternative methods of waste storage such as temporary, near surface storage in a solidified form. The AEC decided at that time to investigate thoroughly methods based on technology already in hand rather than to pursue a concept that has considerable technical and economic appeal, but which would require considerable additional investigation to be proven. The press release on this decision is given in Reference 17.

The present long-range waste management program for SRP wastes is described in Appendix I.

REFERENCES FOR APPENDIX H

1. Membership of Committee on the Geologic Aspects of Radioactive Waste Disposal, NAS-NRC.
2. "Minutes of December 1961 Meeting of Committee on the Geologic Aspects of Radioactive Waste Disposal," NAS-NRC.
3. *Storage of Radioactive Wastes in Basement Rock Beneath the Savannah River Plant.* USAEC Report DP-844 (1964).
4. Letter John C. Frye to Walter Belter: "Minutes of June 1963 Meeting of Committee on Geologic Aspects of Radioactive Waste Disposal," (July 17, 1963).
5. *Report from Committee on Geologic Aspects of Radioactive Waste Disposal, NAS-NRC to Division of Reactor Development and Technology* (May 1966).
6. Letter Milton Shaw to Dr. Frederick Seitz: "Comments on Report from Committee on Geologic Aspects of Radioactive Waste Disposal, NAS-NRC to Division of Reactor Development and Technology, USAEC, May 1966," (November 7, 1966).
7. *Observations Concerning the Management of High-Level Radioactive Waste Material.* Report from the Comptroller General to the Joint Congressional Committee on Atomic Energy (May 1968).
8. *Programs and Problems in Programs for Managing High-Level Radioactive Wastes.* Report from the Comptroller General to the Joint Congressional Committee on Atomic Energy (November 1970).
9. *Report of the Committee to Study the Establishment of Plants or Facilities for the Recovery of Nuclear Fuel and the Storage of Waste Nuclear Materials.* Report from the Committee of the South Carolina General Assembly to the Governor and General Assembly (1972).
10. *Permanent Storage of Radioactive Separations Process Wastes in Bedrock on the Savannah River Plant Site.* Report by the Consulting Panel convened by Du Pont (May 1969).

11. *A Progress Report of the Panel on Permanent Storage of Radioactive Separations Process Wastes in Bedrock on the Savannah River Plant Site.* Report by the Consulting Panel convened by Du Pont (December 10, 1971).
12. *An Evaluation of the Concept of Storing Radioactive Wastes in Bedrock Below the Savannah River Plant Site.* Report by the Committee on Radioactive Waste Management, NAS-NRC, 1972.
13. *Interim Preliminary Conceptual Analysis Report on the Bedrock Waste Storage Project.* Report by Parsons, Brinkerhoff, Quade, and Douglas, Inc. (July 1972).
14. *Supplement Number 1 to the Interim Preliminary Conceptual Analysis Report on the Bedrock Waste Storage Project.* Report by Parsons, Brinkerhoff, Quade, and Douglas, Inc. (November 1972).
15. *Status Report - Deep Shaft Studies.* Report by Parsons, Brinkerhoff, Quade, and Douglas, Inc. (October 1972).
16. *Triassic Basin Fault Probing Program Report.* Report by Parsons, Brinkerhoff, Quade, and Douglas, Inc. (April 1973).
17. "AEC Postpones Development of Bedrock Project at Savannah River Plant." Press Release (November 17, 1972).