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REPORT TO THE
JOINT COMMITTEE ON ATOMIC ENERGY
CONGRESS OF THE UNITED STATES

# Progress And Problems In Programs For Managing High-Level Radioactive Wastes

B-164052

Atomic Energy Commission

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES



JAN 29, 1971

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D C 20548

B-164052

Dear Mr Chairman·

This is our report on progress and problems in programs for managing high-level radioactive wastes by the Atomic Energy Commission. The review was made in accordance with requests made on October 24 and December 15, 1969

Copies of this report are being sent today to the Vice Chairman of your Committee and to the Atomic Energy Commission.

We believe that the contents of this report would be of interest to other committees and members of Congress Therefore, as agreed to by the Committee, we

Contents

## ABBREVIATIONS

AEC Atomic Energy Commission

GAO General Accounting Office

*COMPTROLLER GENERAL'S REPORT TO THE JOINT COMMITTEE ON ATOMIC ENERGY CONGRESS OF THE UNITED STATES*

PROGRESS AND PROBLEMS IN PROGRAMS FOR MANAGING HIGH-LEVEL RADIOACTIVE WASTES
Atomic Energy Commission
B-164052

## D I G E S T

### *WHY THE REVIEW WAS MADE*

The General Accounting Office (GAO) reviewed the policies and procedures of the Atomic Energy Commission (AEC) for the management of radioactive wastes, to determine the actions taken on the matters discussed in GAO's previous report dated May 29, 1968, on this subject.

This review, like its predecessor, was made at the request of the Joint Committee on Atomic Energy, Congress of the United States.

A subject of widespread concern and interest, AEC's radioactive waste management programs are designed to protect the public, private and public property, and the general environment from the hazards of excessive radiation from radioactive wastes

### *FINDINGS AND CONCLUSIONS*

#### *Progress made*

AEC has made progress in carrying out its programs for the effective management of radioactive waste materials which must be contained and isolated from that part of the earth and its atmosphere where life exists (the biosphere)

Since the issuance of GAO's prior report, AEC has

--Taken further steps to improve policies and practices at its operational sites for the safe storage of high-level radioactive wastes. (See p 15 )

--Made progress toward developing and implementing long-term-storage methods for radioactive wastes being retained on an interim basis in tank storage as liquids and as wet solids (See p. 33 )

--Initiated an evaluation of the adequacy of the policies and practices followed at operational sites in the ground burial of radioactive solid wastes. (See p 48 )

--Taken steps to develop and implement plans for long-term storage of plutonium-contaminated wastes (See p 49 )

--Established (May 1970) a Division of Waste and Scrap Management which will (1) review and approve or disapprove AEC installation waste management plans, (2) coordinate management of storage and ground burial of contaminated solid wastes, and (3) manage operations of Federal repositories for disposal of solidified and solid wastes (See p 9 )

--Announced (June 1970) the selection of a site and plans for the development of an initial Federal repository for the demonstration of long-term storage in salt mines of high-level radioactive solidified wastes and plutonium-contaminated solid wastes. (See p. 61 )

--Published (November 1970) an amendment to its licensing regulations to establish criteria on siting of commercial fuel-reprocessing plants, interim storage of radioactive wastes generated at such plants, and long-term storage of such wastes in Federal repositories. (See p. 64 )

*Problem areas*

AEC is faced with complex technical problems associated with the management of large quantities of high-level radioactive wastes generated at its various installations The bulk of such wastes was generated at the chemical-reprocessing plants prior to the development of the technology now available for handling these wastes

Although considerable progress has been made by AEC, as stated above, problems remain to be resolved and delays are being experienced in implementing certain policies and practices.

GAO has noted that.

--Implementation of some programs to provide for interim or long-term storage of radioactive solidified wastes held in underground tanks has been delayed because of operational and technical difficulties. (See p 15 )

--As the waste storage tanks and engineered systems increase in age and are utilized more because of the accumulation of new wastes, there is an increased possibility of tank incidents occurring until all liquids are removed from the older tanks (See p. 33 )

--The proposal for long-term storage in bedrock caverns of wastes which are now retained in underground tanks at the Savannah River Plant requires further evaluation by underground exploration before it can be approved (See p 33 )

--Considerably more time is believed necessary before a determination can be made as to whether the interim-storage method being employed at Richland for certain wastes (solids in existing tanks) will be acceptable for long-term storage (See p 33 ) 34

--AEC's goal for long-term storage of plutonium-contaminated solid wastes will be more difficult to achieve if it becomes necessary to retrieve and transfer significant quantities of waste buried prior to April 30, 1970, since provision for retrieval was not a primary consideration at the time of burial (See p. 47 )

*Commercially generated wastes*

In addition to managing its own waste, AEC is responsible for regulating practices of commercial firms and for ensuring safe, long-term storage of the large volumes of radioactive wastes that have been and will be generated by licensed fuel-reprocessing plants

With advances in technology, AEC has developed--and must continue to develop--regulations, in advance, so that the problems to be encountered by the emerging commercial fuel-reprocessing industry can be resolved on a reasonably timely basis.

*Conclusions*

Although AEC has assigned a high priority to radioactive-waste management programs, 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.

AEC's decision in June 1970 to develop salt mines for potential use as a Federal repository and its announcement in November 1970 of waste management regulations for private industry are major milestones If the development of the Federal repository proceeds on schedule and proves successful, private operators should be able to avoid the waste management problems of the type experienced in the past by AEC when the lack of technology resulted in the accumulation of large volumes of high-level radioactive liquid wastes.

GAO believes that, to provide greater assurance that appropriate priorities are assigned to the overall waste management program, AEC should further develop and consolidate its plans for resolving waste management problems into an overall coordinated plan Such a plan should provide the following information for each type of radioactive waste generated by both AEC and private industry at the various locations involved

--The current status of the waste management program, both interim and long-term projects

--The specific actions necessary to resolve existing problems and achieve acceptable waste-storage goals

--The time frames over which these actions can be carried out

--The estimated costs involved, by fiscal year, in carrying out these actions.

*RECOMMENDATIONS OR SUGGESTIONS*

The Division of Waste and Scrap Management should give its immediate attention to consolidating and implementing the overall radioactive waste management plan described above. GAO believes that, when such a plan has been established, this Division should be assigned responsibility (1) for recommending priorities for waste storage methods and for coordinating the conduct of research and development of waste storage methods to meet these priorities, (2) for recommending long-term storage methods, (3) for establishing criteria for interim storage, (4) for reviewing and evaluating the progress made by the program divisions, and (5) for coordinating matters affecting both AEC and private industry waste management practices with AEC program and regulatory divisions.

*AGENCY ACTIONS AND UNRESOLVED ISSUES*

AEC officials informed GAO that the Division of Waste and Scrap Management had been assigned the responsibility for developing and implementing a plan for the storage of high-level radioactive wastes from licensed facilities in the proposed Federal repository in Lyons, Kansas, and for managing AEC's alpha, or plutonium-contaminated, wastes The Division also has been directed to coordinate the consolidation of an overall AEC plan for radioactive waste management

The plan, which will be largely a consolidation of plans developed or being developed by various AEC divisions, offices, and contractors, is expected to be completed early in fiscal year 1972 It is to be updated as required to reflect major needs and developments in waste management activities. AEC stated that the Division of Waste and Scrap Management had been or would be given the other responsibilities cited in GAO's recommendation.

The Division of Waste and Scrap Management currently has responsibility for reviewing and approving or disapproving, in consultation with cognizant program and staff divisions, waste management plans of AEC installations This responsibility carries with it the responsibility for monitoring progress toward achieving overall AEC plans and objectives. (See p 70 )

Under present organizational arrangements, AEC's Division of Production will continue to have primary responsibility for the management of high-level radioactive wastes from AEC fuel-reprocessing installations, including responsibility for research and development of long-term-storage methods for such wastes.

GAO was advised that the Division of Production's activities would be conducted in accordance with the approved overall waste management plan and that its efforts to develop or improve storage methods would be coordinated with those of the Division of Waste and Scrap Management. Various budget and organizational alternatives within AEC also are being considered with the objective of ensuring that the approved overall waste management plan will be effectively implemented.

# CHAPTER 1

## INTRODUCTION

In accordance with requests made on October 24 and December 15, 1969, by the Joint Committee on Atomic Energy, Congress of the United States (see apps. I and II), the General Accounting Office has made a review of the Atomic Energy Commission's management of high-level radioactive waste materials. The objectives of our review were to determine AEC actions taken after our prior report to the Joint Committee on observations concerning the management of high-level radioactive waste material (B-164052, May 29, 1968).

Our review was directed primarily toward evaluating certain aspects of AEC's waste management programs at four AEC field offices. We visited two commercial plants: one is generating and one will generate radioactive waste. The scope of our review is described in chapter 6.

The purpose of AEC's waste management policies and procedures is to ensure that waste management activities are conducted in such a manner as to protect

--the health and safety of AEC and AEC-contractor employees and the general public,

--the quality of the environment, and

--private and public property.

The potential hazards to mankind from radioactive wastes stem from the basic characteristics of the wastes' radioisotopic contaminants. Allowing these radioisotopes to decay naturally is the only practicable means of reducing their radioactivity to nonhazardous levels. Although many radioisotopes decay rapidly, some decay at such a slow rate that they could represent a potential hazard to mankind for centuries.

The isotopes in the waste that are of greatest concern to health and safety are generally those which are highly toxic and/or have long half-lives, such as strontium, cesium, and plutonium. AEC's radioactive waste storage tanks contain strontium-90 and cesium-137, which require hundreds of years to decay before they no longer pose a health hazard, and plutonium-239, which requires approximately 500,000 years to decay to an innocuous level.

The plutonium-239 contained in AEC's solid and liquid wastes is in such low concentrations as to be considered uneconomical to recover. According to AEC, it would be impracticable to remove enough of the plutonium from the wastes to have any relative significance with regard to the need to isolate the plutonium-containing wastes from the biosphere. AEC advised us that plutonium buried in the ground has little mobility, since it is relatively insoluble in water. Even if discarded in solutions, plutonium is generally held in the soil close to the point of release for as long as the soil itself remains in place. The potential danger would be from ingestion or inhalation of the contaminated soil or dust.

Radioactive wastes vary widely in the concentration of radioactive materials and radioisotopes. Such wastes may be divided into three categories, as follows:

1. Low-level wastes have a radioactive content sufficiently low to permit discharge into the environment after reasonable dilution or after relatively simple processing. These wastes have no more than about 1,000 times the radioactivity concentrations considered safe for direct release. In liquid form, low-level wastes contain less than a microcurie[1] of radioactivity per gallon.

2. Intermediate-level wastes have too high a radioactivity concentration to permit release after simple dilution, yet they are produced in relatively large

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[1]A microcurie is one millionth of a curie. A curie is a measure of the number of atoms undergoing radioactive disintegration per unit time and is 37 billion disintegrations per second or the rate of decay of one gram of natural radium.

volumes. The radioactivity of these wastes is up to 1,000 times higher than that of low-level wastes, and, in a liquid form, they may contain up to a curie of radioactivity per gallon Intermediate-level wastes are disposed of through treatment, such as filtration or ion exchange, or are buried in the ground.

3. High-level liquid wastes cannot be released into the environment because of their high radioactivity concentration (as much as 10,000 curies per gallon).

Delineation of the categories is dependent on operating parameters at each site location, and therefore the categories are not uniformly defined. For waste management purposes, AEC considers two levels of radioactive wastes· that which must be contained (high-level wastes) and that which can be discharged, without hazard to the biosphere and man, after reasonable dilution or after relatively simple processing (low-level wastes) The matters discussed in this report pertain to those wastes considered by AEC to require some form of containment.

To confine and isolate high-level liquid wastes from biological life, AEC has stored them underground in large steel-lined, concrete tanks and in steel tanks within concrete vaults. The storage of these liquid wastes in tanks requires continual surveillance and can be considered only an interim solution, as the release of contaminants into the immediate surroundings can be avoided only so long as the tanks and their safety backup systems retain their integrity

To provide protection against the possibility of inadvertent release of radioactivity into the environment in the event of a failure in tank integrity, AEC operations offices have been continuing their efforts to reduce the mobility of the wastes by improved methods for safe interim storage and eventual long-term storage of radioactive wastes generated, or to be generated, at AEC operational sites and at private industrial sites. For example, AEC is working toward limiting the liquid wastes held in tanks to in-process wastes--those wastes which are aging to the extent that they will become suitable for the next step in their processing to reduce the mobility of radioactive material by crystallization or conversion into solids.

Radioactive wastes containing numerous radioisotope products have been generated in processing irradiated nuclear fuels at the chemical-processing plants operated by AEC's Richland, Savannah River, and Idaho Operations Offices as well as at the commercial plant of Nuclear Fuel Services, Incorporated, located in West Valley, New York. The Oak Ridge National Laboratory has generated high-level liquid wastes at its radiochemical-processing pilot plant and is currently generating such wastes at its transuranium-processing facility Solid wastes which contain radioactive materials are also generated at these installations.

The irradiated fuels processed at the three AEC chemical-processing plants generally have been uranium fuels from AEC's plutonium production, test, and military reactors. Fuels from nuclear-powered electric plants using light-water reactors are processed in a commercially operated facility

Additional commercial fuel-reprocessing plants are being, or will be, constructed to meet the requirements for processing increasing amounts of irradiated fuels which will be generated at nuclear-powered electric plants. AEC's projected fuel-reprocessing requirements for the civilian nuclear power industry indicate that approximatelt three to six commercial fuel-reprocessing plants will be required by 1985 and that an estimated 60 million gallons of high-level radioactive liquid wastes, or about one tenth that quantity of solidified residues from processing the liquid wastes, will have been accumulated by the year 2000.

In addition to the specific responsibilities of the AEC operations offices for managing radioactive wastes generated at their respective sites, several of AEC's organizational units have responsibilities relating to various aspects of waste management

The Division of Waste and Scrap Management, which was established in May 1970, has overall responsibility for

--overseeing the waste management activities at all AEC operational sites,

--coordinating the operational direction for storage and burial of AEC's solid wastes,

--managing the operation of Federal waste repositories, and

--developing AEC-wide plans for management of scrap containing special nuclear material.

The Division of Production develops and directs programs for producing and processing feed, special nuclear, and other special materials and for associated process development. In conjunction with this function, the Division of Production coordinates and directs programs for high-level waste management and for long-term storage of radioactive waste from the Division's chemical-processing operations.

The Division of Reactor Development and Technology develops and directs assigned reactor development and technology programs. The Division directs also a research and development program on processes for the treatment and storage of high-level radioactive waste resulting, or expected to result, from chemical-processing operations in connection with the nuclear power industry.

Other AEC program divisions, including the Division of Research, Division of Isotopes Development, and Division of Biology and Medicine, because of the nature of their programs, also generate some quantities of radioactive wastes which must be contained

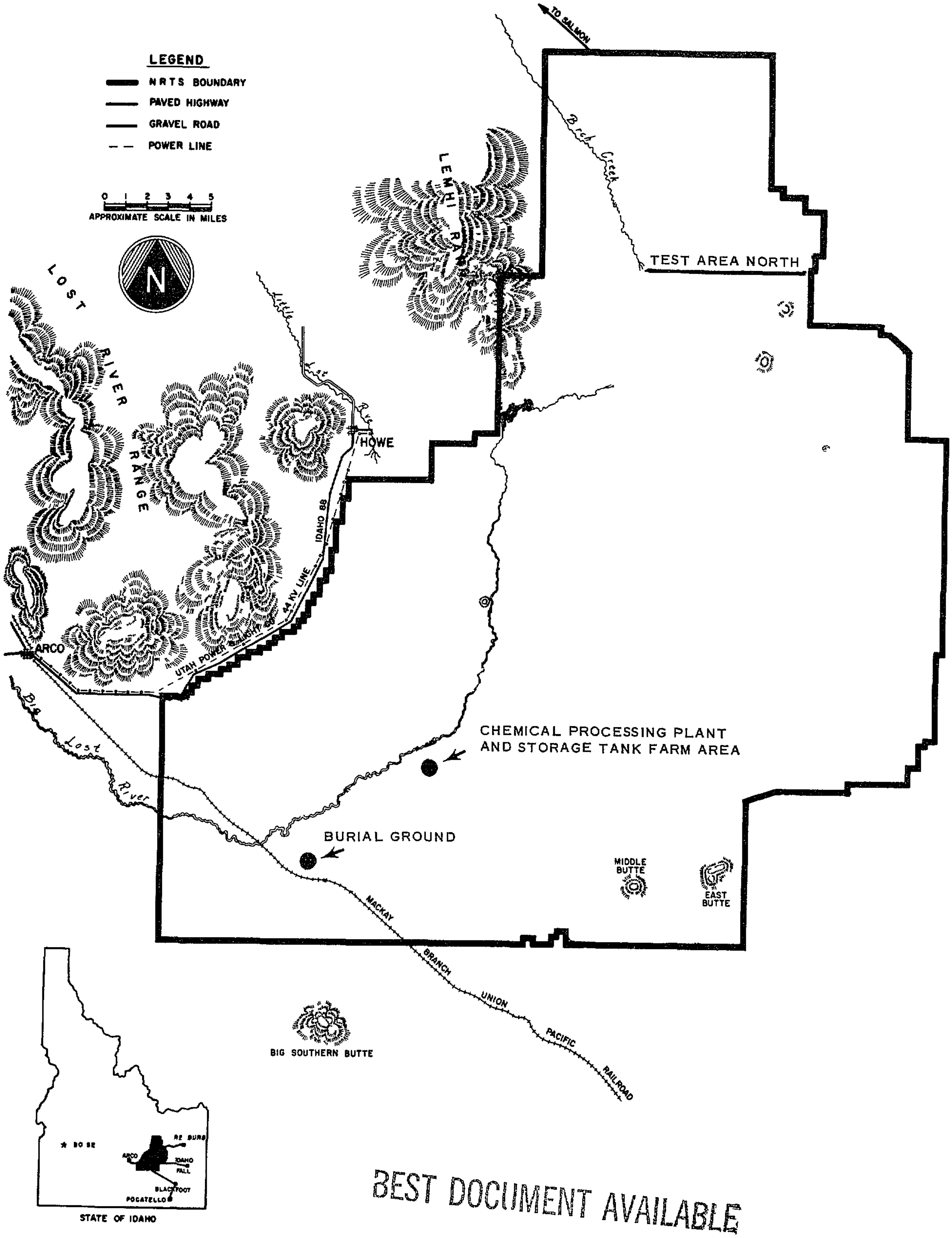
The Division of Materials Licensing is responsible for licensing private facilities for reprocessing irradiated source and special nuclear material and therefore is concerned with the safety of radioactive-waste management activities at such facilities. Since AEC installations are not subject to licensing by this Division, it is not responsible for evaluating the management of AEC's radioactive waste. This responsibility was previously assigned to the Division of Operational Safety, but in June 1970 it was assigned to the new Division of Waste and Scrap Management.

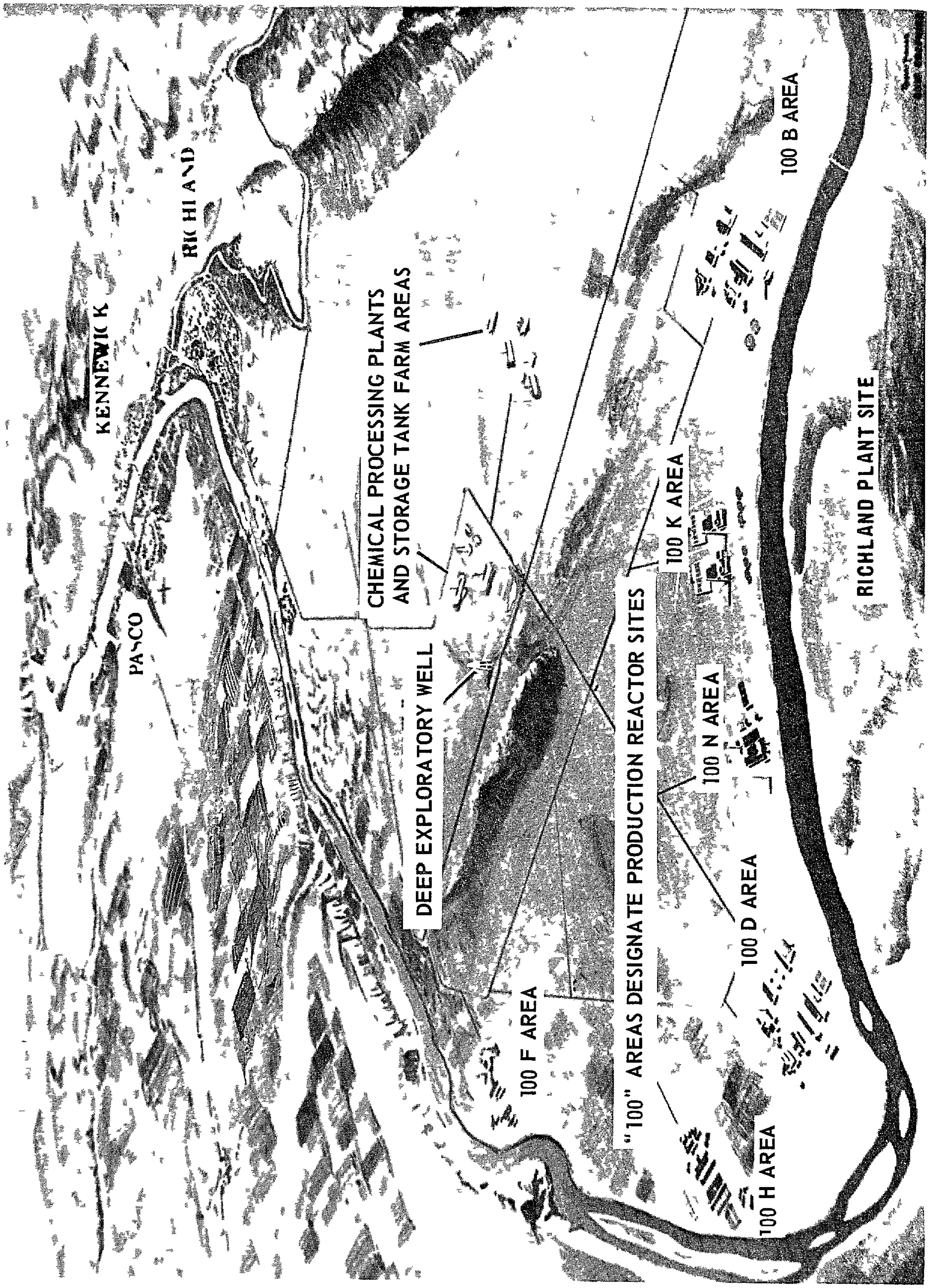
For fiscal year 1970, AEC was authorized $2 3 billion for its various programs. Of this amount, about $28 million represented operating and capital funds authorized for its waste management programs

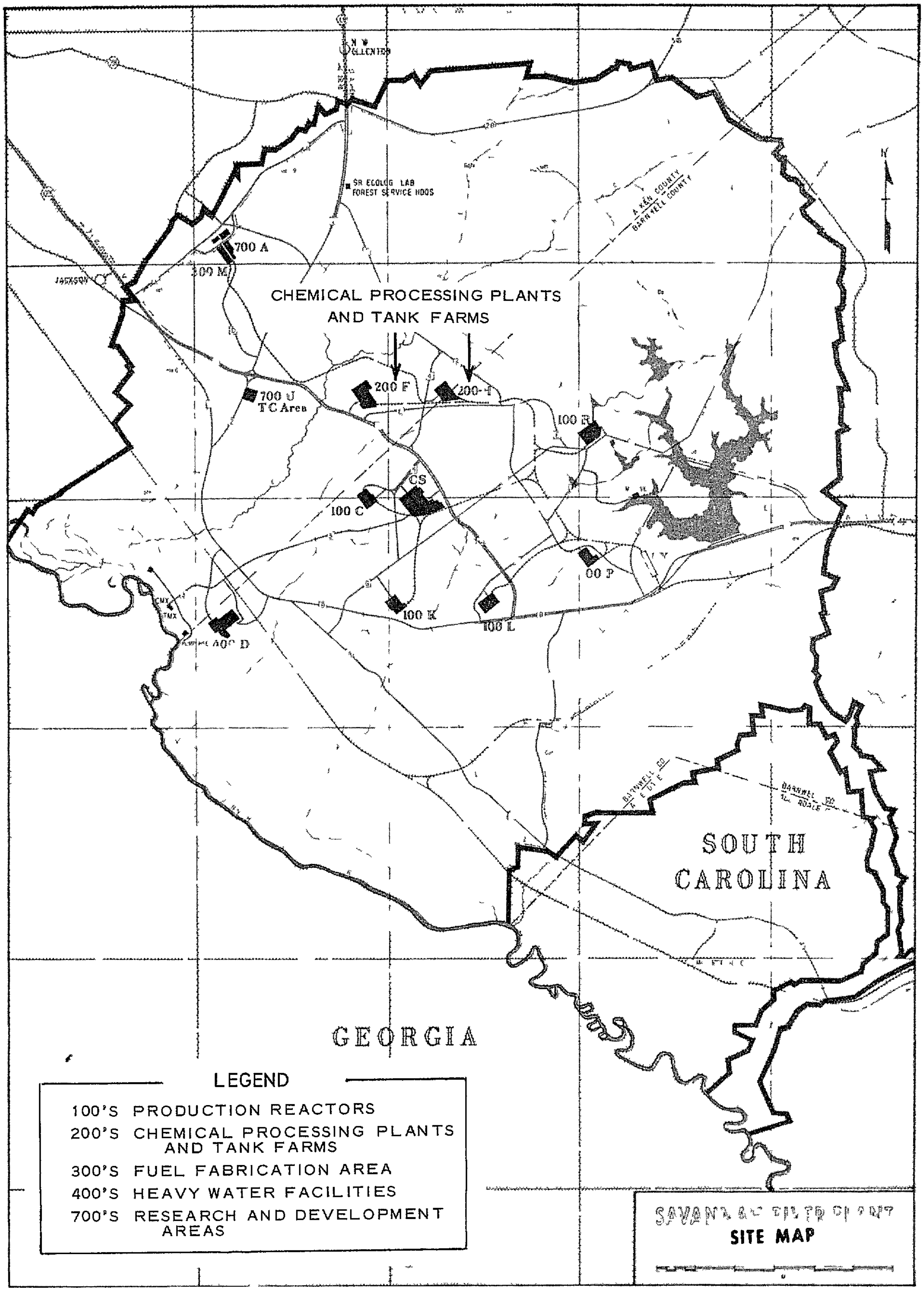
The principal management officials of AEC responsible for administration of activities discussed in this report are listed in appendix III.

The illustrations on the following three pages, which were provided to us by AEC, show the three AEC installations at which irradiated-fuel elements are processed.

## IDAHO NATIONAL REACTOR TESTING STATION (N R T S)




KENNEWICK
PASCO
RICHLAND
CHEMICAL PROCESSING PLANTS
AND STORAGE TANK FARM AREAS
DEEP EXPLORATORY WELL
"100" AREAS DESIGNATE PRODUCTION REACTOR SITES
100 F AREA
100 H AREA
100 D AREA
100 N AREA
100 K AREA
100 B AREA
RICHLAND PLANT SITE

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## CHAPTER 2

## INTERIM AND LONG-TERM STORAGE

## OF AEC'S HIGH-LEVEL RADIOACTIVE WASTES

AEC has made progress toward the development of policies and practices for effectively managing interim storage of high-level radioactive waste materials and for their eventual long-term storage. Since our prior report in May 1968, AEC has endeavored to improve the interim-storage situation by constructing improved storage tanks, reducing the quantity of liquid wastes stored in tanks, and proceeding with the solidification of the tank-stored liquid wastes at two of its operational sites. Also AEC has continued its research and development efforts to provide safe long-term-storage methods.

Interim, or short-term, storage is considered by AEC to be the containment and storage of radioactive wastes safely for tens of years pending decisions on long-term storage methods. Long-term storage is considered to be the containment and storage of radioactive wastes during the hundreds or thousands of years that this material will be biologically hazardous. In-process wastes are those radioactive wastes which are temporarily aging for a number of years to permit the decay of their radioactivity to the extent that the wastes will become suitable for the next step in their processing to a solid form.

Richland has been proceeding with in-tank solidification of low-heat liquid wastes and with removal of the long-lived heat generators--strontium-90 and cesium-137--from high-heat liquid wastes. Removing the cesium and strontium enables the remaining high-heat liquid wastes to decay to low-heat liquid wastes within about 5 years. Richland is developing a process and plans to construct a facility for solidifying and encapsulating the liquid cesium and strontium concentrates.

The solidification of the low-heat liquid wastes into salt cakes in the tanks is considered to be an interim-storage process until AEC makes a determination as to the acceptability of in-tank solidification as a long-term storage method. Also a long-term-storage location has not been selected for the encapsulated strontium and cesium.

Idaho is keeping current with its generation of liquid wastes by converting the wastes, after they have cooled sufficiently, to a granular solid calcine. The calcine is being stored in stainless-steel bins in underground concrete vaults as an interim-storage process. AEC is planning that these wastes eventually will be transferred for long-term storage in a Federal repository.

AEC still has not done sufficient exploratory work on the use of bedrock caverns at Savannah River to determine whether this concept would be acceptable for long-term storage of the Savannah River wastes. In the meantime, these wastes are being segregated on the basis of their heat-generation rates and are being immobilized by evaporation to salt crystals and sludges in the tanks to the extent allowed by their heat-dissipation capability.

The concept of using salt mines in bedded salt deposits for long-term storage of radioactive wastes has been approved, in principle, by AEC. AEC has selected a location near Lyons for further preparatory work and plans to seek project authorization in fiscal year 1972. AEC contemplates making the Lyons mine the initial Federal repository for high-level solidified wastes from commercial fuel-reprocessing facilities.

AEC informed us that the Lyons location probably could be used for long-term storage of AEC's high-level radioactive wastes; however, because of the estimated high cost (preliminary estimates are in the range of $1.5 to 2 billion) of processing, packaging, and shipping the wastes from Richland and Savannah River to Lyons, efforts are under way to determine whether suitable long-term-storage locations and methods can be developed at the two AEC sites. AEC believes that the cost of exploring and developing a long-term-storage method at these sites is justified, because of the potential expense of shipping the large quantities of waste at these sites to another location. AEC advised us that it probably would not be economically attractive for a commercial plant to make similar studies for its own location.

The following table summarizes the individual AEC production sites' interim-storage methods; the proposed long-term-storage plans and their present status; and the possible alternative long-term solution, if deemed necessary.

| Site | Time of storage | | Long-term storage | |
|---|---|---|---|---|
| | Decades (interim) | Centuries (long term) | Status | Alternative solution |
| Richland (note a) (see p 34) | In tank | In tank | Under way | Basalt |
| | Strontium-cesium capsules | Strontium-cesium capsules | Budgeted | Ship to repositories (note b) |
| Idaho (note a) (see p 44) | Calcine in bins | Ship to repositories | Planned | - |
| Savannah River (note a) (see p 41) | Evaporated crystals | Bedrock | Ready for next step | Ship to repositories (note b) |

[a]Storage of in-process liquid wastes will always be necessary, as long as fuel-processing continues Requires high-integrity system of storage

[b]AEC has indicated that the wastes can always be shipped, the approach has been to exhaust the possibility of long-term onsite storage before moving thousands of tons of contaminated wastes

After our prior review, AEC reemphasized the priority of radioactive waste management activities. In May 1968 the AEC General Manager established a task force, composed of assistant general managers, to make a review of the adequacy of policies and organizations regarding waste management activities at AEC installations. The task force review gave priority consideration to Richland, Savannah River, and Idaho waste management activities.

In its report dated August 8, 1968, the task force recommended that planning, programming, and operating responsibilities of program divisions remain as they were but that staff responsibilities be clarified to provide that the Division of Operational Safety:

--Within the framework of AEC-approved policies, principles, and plans, develop, recommend, and promulgate policies, standards, and criteria for waste management activities.

--Exercise overall cognizance, evaluation, and appraisal of waste management activities, specifically including the degree of progress in meeting objectives and schedules, to ensure compliance with AEC policies and approved waste management plans for each AEC installation.

--Serve as a focal point for external relationships in the area of radioactive waste management

Regarding liquid wastes the task force recommended that:

> All liquid radioactive wastes not suitable for routine release be suitably contained with adequate provision for control or recovery in the event of leaks or accidental spillage. Storage of such wastes as liquid in storage tanks not be regarded either as disposal or as an acceptable practice for long-term handling; rather, waste management programs provide for either (1) reduction of such wastes to solid form for long-term storage or (2) transfer of such wastes to long-term storage in deep underground locations. Either approach provide high assurance of isolation of wastes from the biosphere and of resistance to credible internal or external forces.

The task force set a general target date of December 31, 1975, for achieving its recommendations. As a result of the task force report, each AEC installation was required to prepare and maintain plans for management of its radioactive wastes. These plans were to include the AEC operational sites' spare-tank criteria.

At the time of our prior review, we found that, for the tank-stored wastes, AEC had no overall criterion for determining the minimum reserve storage capacity, or spare tankage, to be maintained at all times for emergency situations. Subsequently, the Division of Production instructed the Savannah River, Richland, and Idaho Operations Offices to submit their minimum-reserve criteria and spare-tank philosophy. These criteria, which differed with the conditions and resources available at each site, were reviewed by AEC for safety and sufficiency.

Although these operations offices' criteria were considered by AEC to provide sufficient protection, the Division of Production has considered the possibility of a uniform spare-tank criteria and has developed for its own guidance informal criteria which provide that, as a minimum, at least one spare tank be maintained in each integrated tank-farm complex. Although these criteria currently could not be met by all AEC production sites, the Division's planning and budgeting actions were directed to attaining the capability to meet these criteria at all sites by about 1973. The flexibility then would exist to implement uniform criteria.

AEC advised us that, because nearly all the tank-stored high-level radioactive wastes were at the production sites, the Division of Production's criteria, if formalized, would be essentially agencywide; however, the specific implementation of the criteria at each site would be dependent on the availability of the necessary facilities. In the meantime, AEC and its production sites are reviewing current waste-tank-farm operating practices and spare-tank criteria to determine whether further improvements may be desirable.

We found that in some cases Richland, Savannah River, Idaho, and Oak Ridge did not have at least one spare tank for each integrated tank-farm complex as contemplated by the Division of Production's informal criteria for reserve tank storage. Storage space, however, was available at the operational sites in tanks that were partially filled. Also we were informed by AEC that projects under way or proposed would enable Richland and Savannah River to meet the criteria.

AEC has also been upgrading the quality of its tanks. According to AEC, the use of improved storage tanks, along with waste concentration and volume reduction projects, will enable the operational sites to place less dependence on the need for spare tanks.

Richland's and Savannah River's waste management plans did not include sufficient descriptions of the engineered systems in use or planned to permit AEC headquarters divisions to evaluate the adequacy of systems designed to minimize the possibility of radioactive wastes escaping into the environment through tank leakage or loss of control.

The Division of Production's objectives and plans for high-level waste management at Richland, Savannah River, and Idaho are illustrated on the following page. In essence they are:

1. Improved high-level waste-storage conditions for the interim period, pending the development and approval of safe long-range-storage locations and systems. The improved conditions include:

   a. Immobilization of the stored liquid wastes (except for the in-process wastes) to a retrievable solid.

   b. Upgrading the quality of the tanks and ancillaries used for in-process storage of liquid wastes, incorporating suitable spare tankage.

2. Development of a location and method which will be safe and acceptable for long-term storage of the wastes onsite.

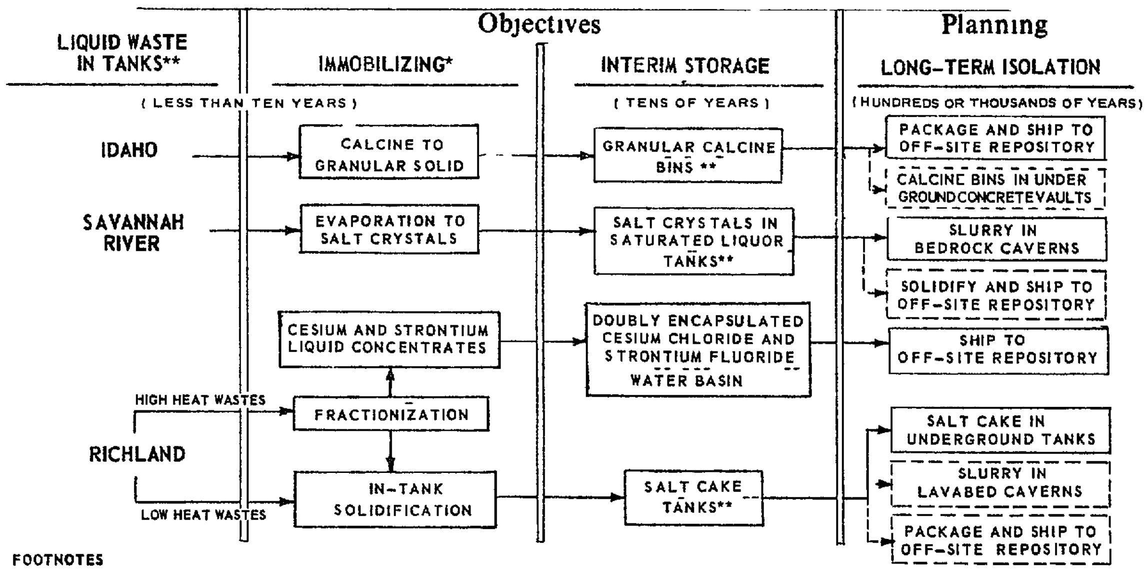
AEC anticipates that objective 1a, except for separated cesium and strontium at Richland, will be achieved for the production wastes at Idaho and Richland by 1976. Also Savannah River wastes will be solidified to the extent technically permissible. AEC stated that objective 1b was a continuing one.

The quantity of wastes stored in tanks has decreased since our prior review. Decreases in volume have resulted from evaporation of the liquid wastes at all sites, in-tank solidification at Richland, and the calcining process at Idaho. Although these processes have reduced the quantity of liquid wastes, large quantities of highly radioactive liquid wastes are still stored in underground tanks.

AEC has about 80 million gallons of radioactive wastes, most of which are in a liquid form, in its underground tanks. The bulk of such wastes, which were generated at chemical-reprocessing plants, was accumulated prior to the development of the technology now available for handling wastes.

AEC advised us that the liquid wastes in the older tanks at Richland were being solidified. AEC anticipates that by about 1976 only the newer tanks of improved design at Richland will contain liquids, and these only for storage of in-process wastes.

PRODUCTION SITE HIGH-LEVEL WASTE MANAGEMENT




FOOTNOTES
CURRENT BY 1976
UNDERGROUND
PREFERRED METHOD
ALTERNATIVE METHOD

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## INTERIM STORAGE OF HIGH-LEVEL RADIOACTIVE WASTES

In our prior report we discussed interim tank storage of high-level wastes in liquid form at Richland, Savannah River, and Idaho and commented.

--that Richland was faced with a potentially serious situation with respect to the condition of its existing tanks and that leaks had been detected in some tanks.

--that some of the tanks at Richland had been in service 10 years or more and that a contractor had estimated that the expected life of those tanks was probably no more than 20 years.

--that a tank leak at Savannah River would be more serious than at Richland, because the leakage from a Savannah River tank could be expected to migrate into the groundwater.

--that Idaho had not experienced any tank failures and that it was continuing to store liquid wastes in tanks on an interim basis, however, Idaho was converting the liquid wastes into a solid form.

--that AEC had not established a standard criterion as to the reserve storage capacity necessary to provide safe operation of storage facilities.

During our current review we found that steps were planned and were under way at Richland and Savannah River to evaporate the liquid wastes to the less mobile solid residues and that only tanks of improved design would contain boiling liquid wastes at these two installations. The current interim-storage situation at the AEC operational sites is discussed below.

### Tank storage capacity

AEC is continuing to store large quantities of liquid wastes in its underground storage tanks but is working toward having all but in-process wastes converted into solid forms. AEC advised us that, although two more tanks at

Richland had developed leaks subsequent to our prior review, only a nominal amount of radioactive liquid wastes was released and that there had been no serious incidents regarding tank storage at the Richland, Idaho, and Savannah River sites subsequent to our prior review. Comments regarding the tank storage of liquid wastes for each site which we visited follow.

Richland Operations Office

The criteria for reserve storage facilities included in Richland's waste management plan provides that:

--For self-boiling wastes (excluding wastes in the tank farm designated as SX), a minimum of one unoccupied tank which is ready for use and equipped with leak detection capability be maintained in each storage area at all times. If the tank designated as the spare tank is one of the previously used single-shell tanks, an additional reserve capacity equivalent to the volume of the spare tank will be maintained in the tank farm for use in the event the single-shell spare tank develops a leak while being filled.

--For nonboiling wastes, at least two million gallons of usable storage reserve be maintained in the tanks at all times.

--The self-boiling wastes in the SX tank-farm complex exhibit heat-generation rates considerably less than those of other waste tanks containing self-boiling wastes. The supernates in these tanks, when stored separately from the sludge, will not self-boil and can be safely stored in the usable storage reserve maintained for the nonboiling wastes. The sludges will not be removed from the tanks and will be air-cooled to maintain their temperatures at safe levels.

According to Richland officials, there are three integrated tank-farm complexes, as follows:

--129 tanks for nonboiling wastes in 10 tank farms connected by interarea and interfarm transfer lines.

--10 tanks for self-boiling wastes in the SX tank farm.

--10 tanks for self-boiling wastes in the A and AX tank farms.

With respect to the available and planned reserve space in these three integrated tank-farm complexes:

--The tank-farm complex for nonboiling wastes had reserve storage space of about 10.5 million gallons at December 31, 1969, but had no completely empty tank available as a spare and had no plans to provide an empty spare tank for this integrated tank-farm complex.

--The SX tank-farm complex for self-boiling wastes has one tank designated as a spare, but on December 31, 1969, this tank was about one quarter full of aged wastes. However, Richland informed us that the boiling liquid wastes in the tanks were aged enough to be transferred to available space in SX tanks for nonboiling wastes, if necessary. Richland's fiscal year 1970 budget provided $2 million for a transfer system to remove the boiling liquid wastes from the SX tank farm for processing into salt cakes. Once this project is completed and the liquid wastes are transferred, there will be no interim storage of liquid wastes in this tank-farm complex. Richland plans to have the liquid wastes transferred by January 1973. This farm system accounts for half of the Richland tanks which have leaked.

--The A and AX tank-farm complexes had two empty, previously used, single-shell tanks designated as spares. These tanks were partially filled with hot water on December 31, 1969, to prevent thermal shock in the event of a hot-waste transfer into the tanks. In addition, two of the planned 1-million-gallon double-shell design tanks mentioned in our prior report were completed in May 1970. When placed in service these tanks will be included as part of the A and AX tank-farm complexes.

Richland's waste management plan, which included a description of its reserve-tank-storage criteria, was submitted to the Division of Operational Safety in January 1969 for review and comment. We were told by AEC that its Headquarters review of Richland's criteria had not included an evaluation of compliance with uniform spare-tank criteria under consideration by the Division of Production; however, the Richland and Savannah River spare-tank-storage criteria, as submitted, were compared with each other and were found to be similar. The Division of Production advised us that projects planned and under way at Richland would provide the necessary facilities to comply with the uniform criteria, if they were implemented.

Savannah River Operations Office

The reserve-tank-storage criteria included in Savannah River's waste management plan provides that, in each tank-farm complex, there be maintained in cooled tanks with good cooling coils spare volume sufficient to receive the contents of the largest tank in the tank-farm complex. Although this practice does not comply with the uniform spare-tank criteria under consideration by the Division of Production, Savannah River has storage tanks under construction which, when completed, will bring it into compliance with these criteria.

Savannah River has two tank-farm complexes designated as the F and H areas. As of December 1969, eight cooled tanks were in service in each tank farm and four new cooled tanks had been constructed in the H area and were soon to be placed in service. Also, each tank farm had four uncooled tanks in service. Savannah River does not consider any unused capacity in the uncooled tanks in determining whether adequate storage reserve capacity is being maintained, because the needed reserve storage capacity is for waste which has to be kept in cooled tanks.

When the four recently constructed cooled tanks are put in service in the H area, Savannah River can comply with the Division of Production's proposed spare-tank criteria in this area, if one of the tanks is designated as a spare. No empty tank is available as a spare in the F area, but compliance with the proposed spare-tank criteria can be accomplished if one of the two tanks scheduled for completion in March 1973 is designated as a spare.

Savannah River was not meeting its own established reserve-tank-storage-capacity criteria. As of December 19, 1969, Savannah River did not have sufficient reserve capacity in its cooled tanks in the F area to hold all the contents of the largest tank in the area. We were told, however, that an interarea transfer line, which had been constructed at a cost of about $2.3 million, could be used to transfer waste to available space in the H area in the event of an emergency in the F area.

In a January 1969 presentation to the National Academy of Sciences' Committee on Radioactive Waste Management, Savannah River contractor's officials stated that it appeared feasible, economical, and safe for Savannah River to continue its interim tank-storage practices until national policy and criteria could be agreed upon for the long-term storage of high-level wastes. We were advised by the Division of Production, however, that Savannah River had been told that it should take necessary steps to have available one spare tank for reserve storage in each area.

Idaho Operations Office

Idaho's waste management plan provides that one cooled 300,000-gallon tank be reserved as emergency storage capacity for self-boiling wastes stored within its tank-farm complex. Idaho has one tank larger than 300,000 gallons, however, we were told that Idaho's criteria provide that no tank be filled with more wastes than can be transferred to the empty tank.

The Idaho waste management plan showed that its Test Area North had two underground 50,000-gallon tanks for the storage of liquid wastes and that no spare tank existed. At the time of our fieldwork, one of these tanks was full and the other contained about 30,000 gallons of concentrated wastes.

We were told that, due to the high chloride content, the wastes stored in the tanks could not be further evaporated and calcined at the Idaho Chemical Processing Plant.

According to Idaho, the remaining tank capacity is sufficient for the foreseeable future if a satisfactory process can be devised and instituted for the treatment of the tank-stored wastes. AEC informed us that the chloride problem had been studied but that further action had been deferred because of funding limitations.

An Idaho official advised us that the Test Area North was not considered to be a tank-farm complex. Another official told us that the tanks were contained in concrete saucers which acted as secondary barriers and had sufficient capacity to hold all the liquid waste should a leak develop in a tank. We were told also that the volume of radioactive wastes stored in Test Area North would be reduced, within a period of years, by natural evaporation to a point where extra tank volume would be available to store wastes.

Idaho's waste management plan was submitted to AEC Headquarters in January 1969. The Division of Operational Safety commented on Idaho's deferral of disposing of liquid wastes stored in Test Area North, as follows:

> "One item on which a decision has been deferred is the 80,000 gallons of Test Area North (TAN) waste which is chemically incompatible with ICPP [Idaho Chemical Processing Plant] waste processing. Since there may be problems in funding treatment of wastes from inactive programs, the next revision of the ID [Idaho] plans should review, at least briefly, the alternatives in this case."

The Division, in commenting on Idaho's plan, did not discuss the adequacy of Idaho's reserve storage capacities. We were told that no determination was made as to whether Idaho's reserve storage available in its waste tanks in Test Area North was acceptable.

Oak Ridge Operations Office

The Oak Ridge National Laboratory's waste management plan did not cite a spare-tank criterion. The Oak Ridge plan states that there are six underground storage tanks containing radioactive wastes in the Laboratory's tank farm; that these tanks have a total capacity of over a million gallons, about half of which is space available for emergency storage of wastes; and that the stored wastes can be pumped from any of the tanks to the others through a system of pipes and valves.

We were advised by an Oak Ridge official that the six tanks had unused space but that each of the tanks contained sludge so that no empty tank was on standby reserve. We were advised by another official that Oak Ridge's practice was to utilize, if needed, unused storage capacity in the tanks and that this could be cited as the spare-tank criterion.

Engineered systems for transfer of wastes

AEC Headquarter's instructions provided that the waste management plans for wastes stored on an interim basis in underground tanks include descriptions of engineered systems to minimize the possibility of wastes' escaping from tanks. The waste management plans of Richland, Savannah River, Idaho, and Oak Ridge did not include full descriptions of the engineered systems in use or planned for transferring tank-stored wastes to reserve storage tanks in the event of tank failures. We were advised by AEC that Headquarters officials had become aware of the existing conditions through periodic field trips.

The bottom portions of the cooled tanks at Savannah River have outer linings of carbon steel, to provide saucers beneath the primary tanks to collect wastes that may leak from the tanks A recycling capability from a saucer back to the tank has been provided, and, in the event of a leak in the tank, the wastes would be recycled back into the tank until they are transferred to reserve tank storage space In 1968 Richland began to construct tanks having a double-containment feature similar to those used at Savannah River

At Richland it would normally take about 9 to 10 days to transfer the liquid wastes from one of the largest tanks, if it was full of liquid, to a reserve storage tank in the event of a tank failure. At Savannah River it would take about 9 to 10 days to transfer the liquid wastes from one of the cooled tanks if it was full of liquid Depending on the quantity of liquid in the tank, between 3 and 14 days would be required to transfer the contents from one of the uncooled tanks at Savannah River.

We were told by Savannah River that the recycling capability of its tanks was adequate to handle leakages of the magnitude experienced in the past and that this recycling should prevent wastes from escaping while a tank's contents were being transferred to other tanks.

The Richland contractor's officials told us that, if weather conditions were favorable, about 2 to 3 days were required to install a pump directly into a tank and to make the necessary transfer-line connection changes in an underground routing box We were also told by a Richland contractor's official that a pump normally would not be installed on a windy day, because of the possibility of releasing radioactive material We were told also that, if a leak developed in a tank having a pump, the time required before the wastes could be pumped from the tank would depend upon the number of transfer-line connection changes that would have to be made in the appropriate underground routing box, that, once the pumping began, the liquid wastes could be transferred to another tank at the rate of about 100 gallons a minute A Richland contractor official said that about 1 week would be required to transfer the liquid wastes from a 1-million-gallon tank, the largest Richland underground storage tank, if the tank was full of liquid

Under the engineered tank-storage system at Savannah River, a transfer jet has been installed in each of the four cooled, double-shelled, underground storage tanks which had experienced leaks Consequently no setup time is needed before the wastes can be transferred from these tanks to reserve storage tanks

A Savannah River official said that the installed transfer jets and related equipment could transfer the wastes at about 75 gallons a minute and that, at that rate, it would take about 9 days to transfer the contents from the largest of the cooled tanks if the tank was full of liquid. AEC advised us that, under its evaporation program, the liquid in many tanks constituted only 40 percent of the volume; thus, in such cases, less than half the indicated time would be required to empty a tank.

The other 12 cooled tanks at Savannah River do not have the capability for immediate transfer of wastes in the event of an emergency situation, such as a leak Before wastes could be transferred from these tanks in an emergency, transfer jets must be set up, which would provide a capability to transfer the wastes at a rate of 75 gallons a minute We were advised that it would take about 1 day to install a transfer jet and about 9 additional days to transfer the wastes from the largest of these cooled tanks, provided that the tank was full of liquid In the interim, Savannah River would depend on the saucers and the recycle capability to prevent escape of the leaking wastes. We were told that the high salt content of the liquid wastes minimized their mobility

At the time of our fieldwork, Savannah River was installing, or was planning to install, permanent-type waste-transfer piping for the eight uncooled waste tanks in the F and H areas, which would reduce setup time needed for installing transfer capability. These uncooled tanks have pumps that have the capability of handling a leakage of 20 gallons or less a minute through a recycling operation by means of an underground drainage sump and sump pump

A Savannah River contractor official advised us that 2 days would be required to install a temporary 75 gallon-a-minute transfer system and that about 12 additional days would be required to transfer the contents from one of the uncooled tanks We were informed by the contractor official that authorization to install the permanent transfer capability in the tank groups had been delayed because of funding considerations and that, if the project was initiated in fiscal year 1972, the transfer systems should be operational by late 1973

On three occasions within a 3-week period in September 1969, Idaho inadvertently discharged some unprocessed radioactive solution from its chemical-processing plant directly into a 600-foot-deep discharge well which extends into the acquifer These discharges were caused by improper operation of a steam-heat system between a dissolver vessel and the service waste line, however, the cause was not identified until after the third discharge had occurred

We were advised by the Idaho Operations Office that the initial incident had been undetected because of the insignificant quantity of radioactivity released and that timely investigation to discover the cause of the second discharge had not been made because of consecutive, higher priority alarms triggered by a power outage.

During September 1969, the month in which the accidental discharges occurred, the average concentration of strontium-90 (the controlling radioisotope) in the discharges into the chemical-processing plant's disposal well was about two times the allowable limit We were advised by Idaho that the average yearly concentration is considered in determining compliance with release criteria and that the average yearly concentration in this case was within allowable limits

The Division of Production informed us that, prior to the accidental discharges, a project for a cooling-water protection facility had been included in the fiscal year 1971 budget and that the incidents provided additional impetus for obtaining the project's authorization The facility, which is now under construction and which is estimated to cost approximately $700,000, will provide radiation monitors, valves, and piping to divert the total flow of contaminated water to another tank until the defective equipment has been shut down and the system flushed of contamination

## Conclusion

AEC has required each of its field operations offices to develop waste management plans and has established the topics to be covered in the plans. The plans have been reviewed by the responsible AEC Headquarters divisions, and comments thereon have been provided to the field operations offices. It does not appear, however, that the AEC Headquarters reviews of these plans were made in sufficient depth to fully evaluate the plans and differences among the operational sites' spare-tankage criteria and the need for a uniform criteria.

Because of the technical factors involved, we are not in a position to comment on the adequacy of the interim storage practices at AEC installations. We were advised by AEC that operational sites' waste-transfer capabilities and available storage space in the past had provided for adequate operation of tank storage facilities. As the tanks and engineered systems increase in age and are utilized more because of the accumulation of new wastes and movement of wastes between tanks, however, there is an increased possibility of tank incidents occurring until all liquid wastes are removed from these old tanks. AEC told us that Richland was in the process of replacing the older tanks containing high-level liquid wastes with improved double-shelled tanks.

## LONG-TERM STORAGE OF RADIOACTIVE WASTES

At the time of our prior report to the Joint Committee in 1968, AEC was taking actions at Richland, Savannah River, and Idaho to develop methods for the safe long-term storage of radioactive wastes. Richland was developing processes for solidifying its liquid wastes. Savannah River was conducting research and development on long-term storage of wastes in the bedrock formation below the Savannah River plant site. Idaho was operating a waste-calcining facility to convert its liquid wastes into a solid granular form for storage in bins.

AEC has established waste management policies providing that storage of high-level liquid wastes in tanks is an unacceptable practice for long-term storage and that all but in-process liquid wastes should be either converted into a solid form or transferred to deep underground locations for long-term storage.

We were informed by AEC that the salt mines in Kansas were being considered as a long-term-storage repository for all AEC-generated high-level waste but that the AEC operational sites were following or developing alternative storage methods which were more economical and were being considered by the sites as acceptable for long-term storage. Some of these alternative methods are extensions of the interim-storage methods being used. Methods being considered to provide for long-term-storage of high-level wastes at the sites are discussed below.

Richland Operations Office

At the time of our 1968 report, Richland had begun separating strontium and cesium, the long-lived fission products, from the accumulated self-boiling wastes (fractionation) and temporarily storing these two radioisotopes as liquid concentrates in the waste fractionation facility with the intent of eventually storing them as solids in high-integrity containers (encapsulation). After fractionation, the remaining nonboiling liquid wastes were being transferred to storage tanks for solidification. At that time, Richland planned that its currently generated self-boiling wastes would be treated for the removal of strontium and cesium, after which they would be stored in tanks to allow short-lived fission products to decay. The accumulated nonboiling wastes were being solidified in tanks to a salt cake In 1968 AEC reported that 25 percent of the nonboiling waste accumulated at Richland was in solid form.

Richland has continued to convert its high-level liquid wastes to a solid form within the storage tanks. We were advised by Richland officials that Richland would meet the general target date of December 31, 1975, for having all wastes, except in-process liquid wastes, solidified in tanks but that it was anticipated that a decision would not be made for about 10 years as to the acceptability of in-tank solidification as a safe, long-term-storage method. They stated that in the meantime Richland would continue to perform research on alternative long-term-storage methods in the event in-tank solidification was deemed unacceptable for long-term storage.

From start-up in March 1965 to December 31, 1969, Richland spent about $4.9 million in operating the in-tank-solidification facilities. Three different evaporator facilities are being used for in-tank solidification. The cost of constructing these three evaporators was about $2.1 million as of December 31, 1969. AEC estimated that about $492,000 more would be spent to complete modifications then in process.

In accordance with its plans to meet the 1975 target date, Richland requested authorization of an additional $6.3 million for construction of in-tank-solidification facilities. This request was included in the 1971 authorization request, and the facilities have been authorized. According to Richland, these facilities will provide the additional capability required to meet AEC's target date of having all but in-process liquid wastes solidified.

In January 1968, a Richland contractor issued a preliminary safety analysis report on the long-term hazards of wastes solidified in underground tanks. In the report, as revised in January 1970, the contractor stated that the wastes would not be transported into the atmosphere or into the groundwater under foreseeable environmental conditions and that, if this method of storage was compatible with "national criteria"--yet to be defined--the solidified wastes could be left in this state indefinitely.

In June 1969, AEC Headquarters asked Richland for an estimate of when a more definitive, or a final, hazard analysis would be available. Richland reported that about 7 to 10 years would be required to accumulate sufficient information on salt-cake characteristics and storage effects before an acceptable, final safety analysis could be prepared.

The Richland contractor's long-range cost forecasts indicated that the operating costs of fractionating the wastes, encapsulating the cesium and strontium, and solidifying wastes in tanks would amount to about $102 million for the 10-year period beginning with fiscal year 1971. He estimated that additional capital funds of about $37 million would be required for the same period. As of December 31, 1969, Richland had spent about $38 million for operating costs and capital facilities toward implementing this proposed long-term-storage method.

At the time of our prior review, AEC estimated that about $12.5 million had been, or would be, spent at Richland for constructing facilities for the fractionation process. As of December 31, 1969, about $15.3 million had been spent in constructing such facilities and AEC estimated that $513,000 additional would be spent on projects in process.

Richland had established target dates of September 1973 for the removal of strontium from stored sludge and September 1974 for the removal of cesium from the stored liquid wastes. Richland, however, does not plan to remove the strontium from about 792,000 gallons of stored sludge which is in the oldest tanks for self-boiling wastes, some of which have leaked. According to AEC, the sludge is considered essentially solid. Richland's decision to retain the sludge in the tanks is based on a demonstrated prototype and on the concept of minimum risk. According to Richland, air cooling the sludge for 25 to 50 years will cause it to solidify satisfactorily in place without fractionation. The liquid wastes from these tanks are to be transferred to the fractionation facility for the removal of the cesium, after which the liquid wastes will go to in-tank solidification.

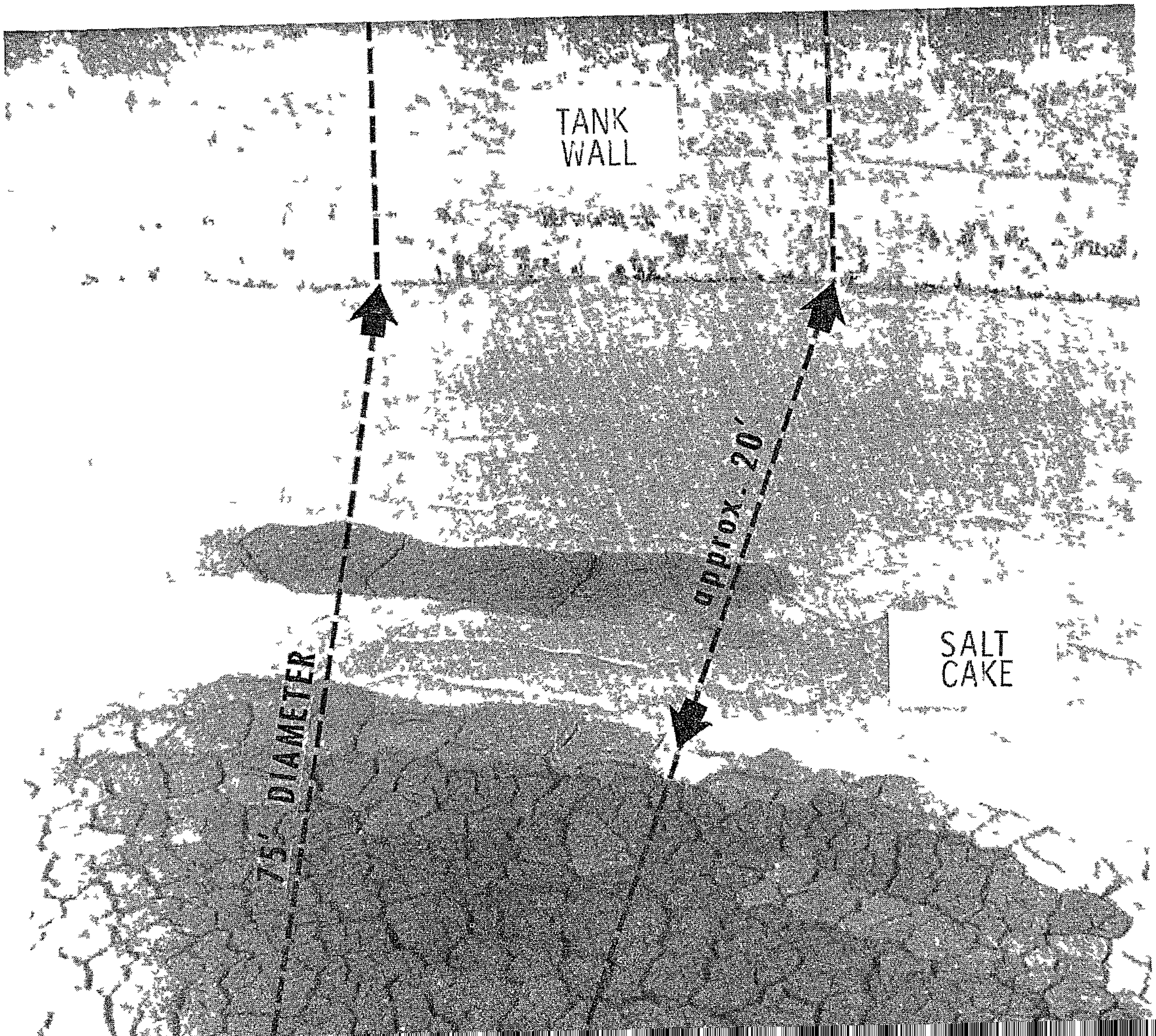
In its fiscal year 1970 budget, Richland requested $2 million to construct facilities for the transfer of wastes from the tank farm with the oldest self-boiling wastes to the waste fractionation facility. At the time of our review, the design of these facilities had begun. Because of Presidential funding limitations on new construction, the total funds were not made available until July 1970. AEC told us in January 1971 that the facilities were being constructed.

As of December 31, 1969, Richland was behind schedule on its programmed rate for strontium removal, about 811,000 gallons of stored sludge remained to be fractionated compared with 700,000 gallons programmed to be remaining at that date. Richland's program for cesium removal was on schedule at December 31, 1969; about 12.7 million gallons of liquid wastes remained to be fractionated. According to Richland, planned additions are necessary to the high-level waste-processing system for waste fractionation of both stored and current wastes to meet the December 31, 1975, date for solidification of all but in-process liquid wastes. An illustration of the first in-tank-solidified salt cake, which was provided to us by AEC, is on the following page.

In its fiscal year 1971 budget, Richland requested and was authorized $1.7 million to provide additional interim storage facilities for cesium and strontium and to construct high-level waste-transfer lines and sludge-removal facilities. According to Richland, this additional storage in the waste fractionation facility would provide for the storage of cesium and strontium concentrates until 1974 when it plans to begin waste encapsulation processing.

Richland has selected a process for solidifying and encapsulating the long-lived fission products but does not expect to have its presently stored inventory encapsulated before 1979. A facility, scheduled for completion in 1973, is being constructed for solidifying and encapsulating the cesium and strontium. Richland has stated that, after encapsulation, these fission products could be stored on an interim basis in water basins, possibly as long as 100 years. AEC has not selected the method to be used for long-term storage of the encapsulated products.

As previously stated, until the solidification and encapsulation facility is in operation, the cesium and strontium removed from the wastes are being stored in tanks inside the fractionation facility. In March 1970, during an attempt to measure the liquid level in an interim-strontium-storage tank in the fractionation facility by means of temporary instrumentation that has since been removed, there was an accidental release of strontium from the tank into an open 25-acre pond within the site boundaries. Water samples from the pond reached a strontium concentration level exceeding AEC's standards for releases of radiation.


TANK WALL
approx. 20'
SALT CAKE
75' DIAMETER

A contaminated ditch was completely screened over and partially backfilled, but the pond remains open. Richland has maintained surveillance of the pond and has used noise guns in an attempt to prevent the use of the pond by waterfowl, however, some coots and ducks have landed on the pond. Richland officials advised us that their analysis had shown that consumption by a person of 1 pound of the contaminated waterfowl generally would be expected to result in that person's receiving an intake of about 1 percent of the maximum permissible body burden of two microcuries of strontium-90; however, in some waterfowl the amount of radioactivity from other isotopes was higher.

Richland officials told us that emergency procedures have been provided at the fractionation facility for the manual diversion of such contaminated releases into an emergency ditch. Also we were advised that Richland planned to include in its fiscal year 1972 budget a request for a $5.3 million project which would provide the capability to divert contaminated cooling-water and chemical-sewer streams from the fractionation and chemical-processing plants to underground storage tanks. This project would provide Richland with a diversion capability similar to that now existing at the commercial chemical-processing plant in New York State. (See p. 56.)

Both AEC and Richland advised us that the method for long-term storage of encapsulated cesium and strontium had not been selected and that, as a result, Richland was uncertain as to the number of years of interim storage that would be required before the encapsulated products could be routed to a final storage site. AEC anticipates that final storage could be in salt mines.

In 1969 Richland began a study of deep-cavern storage of radioactive wastes as an alternative to its proposed long-term-storage method of solidifying wastes in tanks. The objective of this study is to investigate the feasibility of isolating radionuclides from the biosphere in caverns mined in the basalt deep beneath the site. Under this storage method, the salt cake resulting from the in-tank solidification of liquid wastes would be removed from the tanks in a dry state, water would be added in the transfer system, and the slurried waste would be transported to underground caverns 2,000 to 4,000 feet below the surface. According to the Richland contractor's estimates it would cost about $150 million to place the salt slurry in caverns.

At the time of our fieldwork, Richland was conducting a $1.6 million project for drilling exploratory wells to secure geological, hydrological, and other physical data to be used in evaluating the suitability of subsurface formations for storage of radioactive wastes for centuries. Work on the project was scheduled to have been completed by the end of 1970. The AEC contractor for this project reported that sufficient data had been acquired to justify additional drilling to fully evaluate the area for an underground-storage facility.

At the time of our fieldwork, the contractor had not submitted a plan to AEC for the development of the underground caverns. We were informed, however, that full evaluation of the hydrological and geological characteristics was to be made. The AEC contractor had established December 1975 as a milestone date for acquiring data sufficient for reaching a decision on the feasibility of continuing the investigation of long-term storage of wastes in mined caverns at the Richland site. In forecasting future expenditures, the contractor estimated that $7.3 million additional would have to be spent on studying this method of long-term storage through fiscal year 1975.

Savannah River Operations Office

Since our prior review, essentially all research at Savannah River directed at finding a long-term solution for storing high-level radioactive wastes has continued to be on exploring the feasibility of bedrock-cavern storage In 1967 Savannah River reported that the bedrock-cavern-storage concept for long-term storage had been developed to a point where the next major step in determining the feasibility of this concept was the construction of an exploratory shaft, however, approval has not been obtained for construction of the exploratory shaft

Because of the delay in proving the suitability of the bedrock caverns for long-term storage, Savannah River (1) will not meet the December 31, 1975, general target date for having all but in-process waste in long-term storage, (2) will have a significantly larger inventory of radioactive waste stored in underground tanks on an interim basis, (3) may need to construct, at currently projected rates of waste generation, additional tanks for interim storage of waste late in the 1970's, and (4) plans to spend $375,000 in the next few years exploring an alternative to its proposed long-term-storage method

In our prior report, we noted that AEC planned to request $1.3 million for designing the bedrock-cavern project in fiscal year 1970 and, if the project still appeared feasible, to request construction funds in the fiscal year 1971 and 1972 budgets

In August 1968, a panel of consultants began a detailed analysis of the bedrock-cavern-storage concept In May 1969, the consultants reported that the bedrock-cavern-storage concept had promise of offering a permanent solution to the critical waste-handling problem and stated that definite assurance could be provided only by the actual construction of the shaft and several of the exploratory tunnels. In July 1969, a project to locate the construction site, including necessary drilling and preconstruction design and engineering, was authorized for $1.3 million.

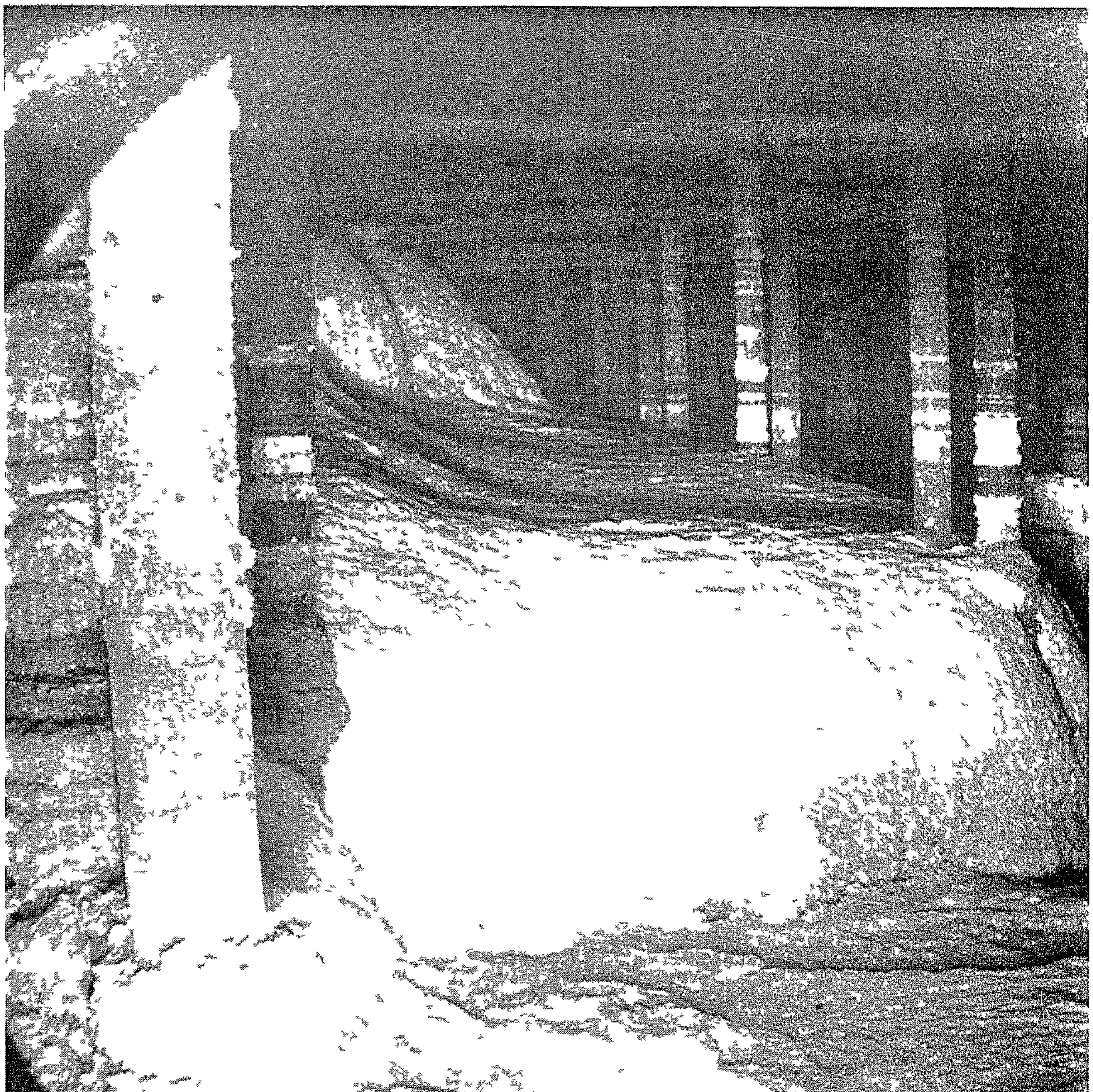
AEC officials stated that, for the bedrock-cavern-storage project to proceed, about $10 million would be needed for construction of at least the shaft and exploratory tunnels. They stated also that, because of budgetary considerations, these funds would not be available in 1971 and that the $10 million project was planned as a fiscal year 1972 budget submission.

Savannah River officials stated that, if fiscal year 1972 funds were authorized for the bedrock-cavern project and if the project was successful, it would be about 1981 before Savannah River could meet the objective of having all but in-process waste in long-term storage. In 1963 Savannah River requested $12.5 million to provide bedrock-cavern-storage facilities; however, it currently estimates that more than $50 million will be needed for the storage facilities. The increased estimate is due to escalation, an increase in the size of the cavern, and additional engineering features.

Savannah River stated that, until it placed its waste in long-term storage, it would continue to store significant quantities of radioactive solid and liquid wastes in underground tanks. Its waste-inventory projections for fiscal years 1970-80 indicate that a peak inventory of over 16 million gallons of solidified and liquid wastes would be stored in tanks during that period, the Division of Production estimates that more than half of the wastes will be in the form of salt crystals. (See photograph on p 43.)

In September 1969, Savannah River informed the Division of Production that no additional waste tanks would be required beyond the two then being constructed, if the bedrock-cavern-storage facilities were constructed and placed in-service by fiscal year 1980 but that, if the bedrock facilities were not available for use by fiscal year 1980, budgeting for additional tank capability (one or two tanks) in fiscal year 1977 might be necessary This estimate was based on the assumption that all existing tanks would maintain their integrity

In the past Savannah River's program on alternatives to bedrock-cavern storage had been to keep current with the extensive research at other AEC sites on various methods for solidifying wastes. In an August 1968 report, however, an AEC task force on waste management recommended that



Savannah River develop an alternative waste management program. As a result, Savannah River proposed a program for additional research and development to provide a definite alternative to bedrock-cavern storage. The proposal provided, as the principal alternative to be considered, the conversion of wastes into solids and their shipment offsite for eventual storage in salt mines. Savannah River estimated that it would cost about $700 million to solidify its wastes and ship them offsite to salt mines.

The proposal suggested that research and development necessary to adopt a calcination process for these wastes could be performed by the Oak Ridge National Laboratory in collaboration with Savannah River. Savannah River estimated that funding requirements for the initial phases of the project through fiscal year 1972 would be $375,000. AEC's Division of Production suggested to Savannah River that work on this project be initiated in fiscal year 1970 within available funds. We were informed by AEC that Savannah River had initiated work on waste calcination technology.

Idaho Operations Office

Since our prior review, Idaho has continued to convert its liquid wastes into a solid form by calcining for storage in bins in underground concrete vaults and has proposed this method for long-term storage. At December 31, 1969, over 1.8 million gallons of liquid wastes had been converted into solids and placed in bins. Idaho reported in its waste management plan that by fiscal year 1974 it should be current in its solidification program.

AEC informed us that all high-level wastes accumulated through 1966 were scheduled to be processed in the calcining facility by about January 1972 and that it should be able to meet the AEC goal for solidifying all but in-process liquid wastes. AEC informed us also that it was planning to remove solid alpha wastes (plutonium bearing) from the Idaho site for deposit in salt mines, because that appeared to be a better method for attaining long-term isolation of these wastes. The material to be transferred would include the calcined wastes if they meet the as yet undetermined criteria (see p. 49) for determining the wastes to be transferred. AEC plans to begin shipments of the alpha wastes to a salt mine during this decade, and AEC's preliminary estimates indicate that excavation, processing, and shipment of such wastes, including the calcined wastes, will cost about $60 million.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory has developed a method of disposing of its nonreleasable radioactive wastes based on the oil-field technique of hydraulic fracturing. The wastes are mixed with cement and other additives and are then pumped down a well into the ground and out into an essentially horizontal fracture within a rock formation adjacent to the Laboratory.

Since the hydraulic-fracturing facility became operational in December 1966, more than 700,000 gallons of radioactive liquid wastes, which could not be routinely released into the environment, has been pumped into the ground Oak Ridge's calculations show that the capacity of the formation at the existing well is at least four million gallons of radioactive wastes before there is any danger of failure of rock cover and that the Laboratory can continue to use the present facility for about 20 years.

Oak Ridge advised us that primary containment and shielding of the radioactive wastes stored under this method is provided by the rock cover and that secondary containment is provided by proper selection of the solidifying additives but that the removal of these injected wastes from the rock-storage location for relocation, in the event it was later required, was considered to be extremely difficult. We were advised by AEC that use of this storage method had been discontinued pending further evaluations.

Conclusion

We recognize that there are difficulties involved in determining the adequacy of storage methods which must provide for safe storage of radioactive wastes for hundreds of years Delays in determining long-term-storage methods, however, result in (1) use of interim-storage methods for long periods of time, (2) continuous research on various alternative long-term-storage methods, and (3) a greater possibility of additional costs' being incurred in changing the physical characteristics of the waste and constructing additional interim-storage facilities

We believe that, to expedite the development of methods for placing its high-level wastes in long-term isolation, AEC Headquarters should place greater emphasis on evaluating the actions being taken by its contractors, determining the adequacy of long-term-storage proposals, and taking the steps needed to accomplish long-term storage

# CHAPTER 3

## GROUND BURIAL OF RADIOACTIVE SOLID WASTES

AEC and its contractors have recognized that potential hazards are associated with the ground burial of radioactive solid wastes that could result in the release of radioactive material into the environment. According to AEC, the burial practices followed by Richland, Savannah River, Idaho, and Oak Ridge have not resulted in releases of radioactivity beyond the confines of the burial grounds that exceed AEC's concentration guides and exposure limits. AEC and its contractors told us that radioactive solid wastes could continue to be buried safely at AEC operational sites, provided that surveillance was maintained over the burial grounds. Because of plutonium-239's long half-life (24,000 years), the hazardous concentrations of plutonium decrease very slowly, and there can be no assurance that surveillance will be maintained for the hundreds of thousands of years during which the plutonium would constitute a potential hazard.

Radioactive solid wastes are radioactive materials which are essentially dry or which contain adsorbed or absorbed fluids in sufficiently small amounts as to be relatively immobile in the soil. The AEC-generated radioactive solid wastes generally include such items as contaminated equipment and materials and residues of production research activities. Most of these wastes have been buried in the ground. As of December 31, 1969, the four AEC operational sites included in our review had utilized a cumulative total of approximately 630 acres of land for burying over 22 million cubic feet of radioactive solid wastes.

Once radioactive solid wastes are buried in the ground, potential hazards over the extensive periods of time that they must be isolated include:

--the leaching of radioactive material from the buried solid wastes and the eventual uncontrolled migration of hazardous concentrates of this material through and into the groundwater,

--the upward migration of radioactive material through the roots of plants,

--the transport of radioactive material resulting from the encroachment into the burial grounds by animals or humans, and

--the soil erosion resulting in the radioactive material's being exposed and possibly transported by the air or water.

The last three potential hazards listed above would be likely to occur only if proper surveillance were not maintained.

In October 1969, AEC's General Manager reestablished the Task Force on AEC Operational Radioactive Waste Management. The General Manager requested the task force to make an intensive study of the policies and practices regarding the ground burial of radioactive solid wastes at AEC operational sites and to evaluate the adequacy of such policies and practices.

On March 20, 1970, the General Manager issued a policy statement implementing the recommendations of the task force. This policy, applicable to burial of all solid wastes after April 30, 1970, provided, in general, that wastes having known or detectable contamination of transuranium nuclides, which include plutonium, be so packaged and segregated in the solid-waste burial grounds that they can be readily retrievable within a period of 20 years.

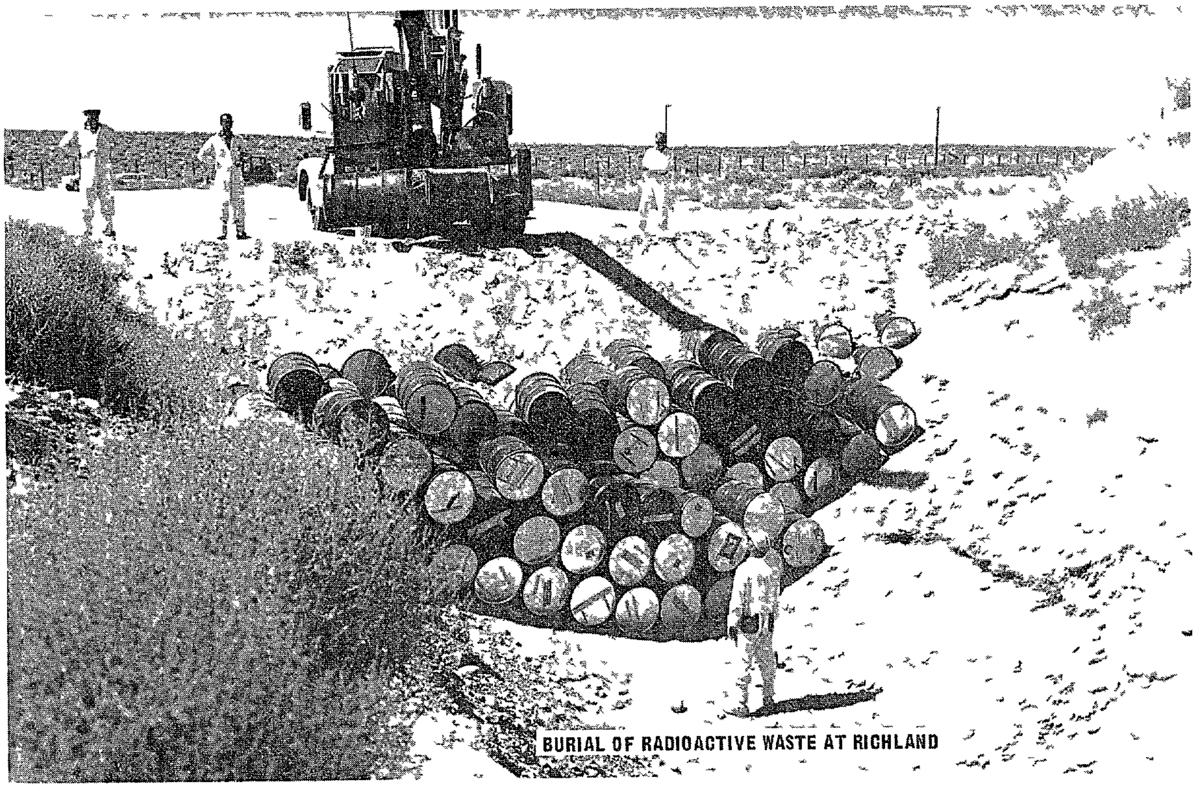
Prior to April 30, 1970, provision for retrieval was not a primary consideration in solid-waste burials, and it would be difficult to retrieve those wastes if AEC should so desire.

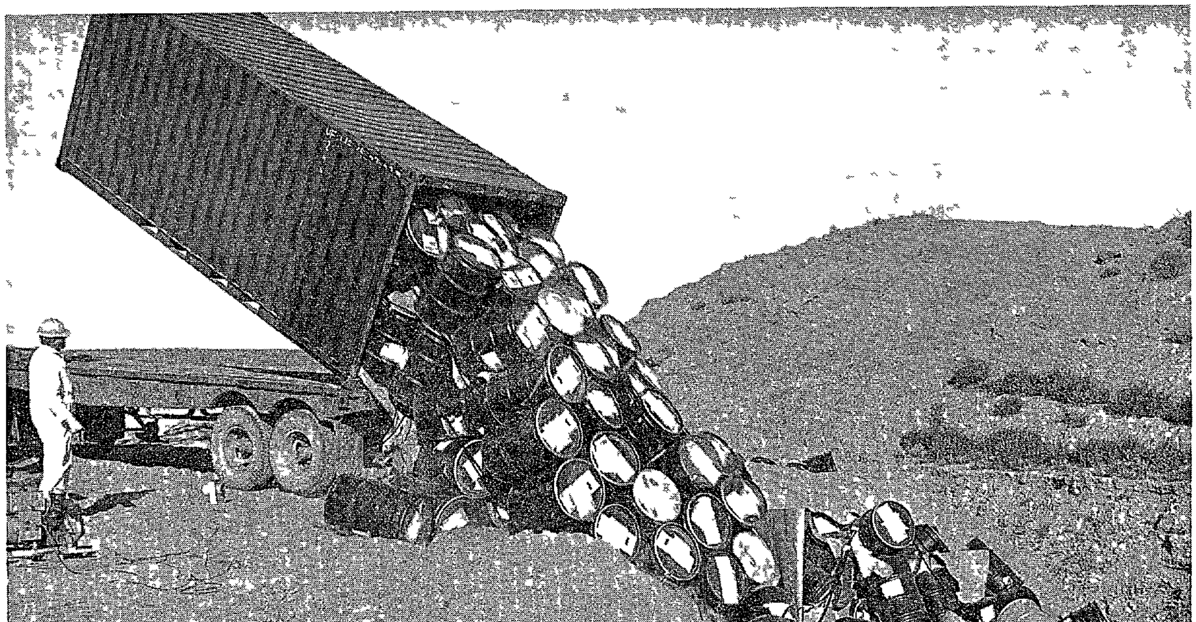
In general, prior to April 30, 1970, (1) no standard packaging procedures had been established, (2) different burial techniques were used at the various operational sites, and (3) records indicating volumes and exact locations were not available for all buried solid wastes. Packaging of these radioactive wastes was designed to maintain safety until it was buried, but, after burial, the ground was relied upon to confine the wastes. AEC told us that the various procedures used at the operational sites were considered to be adequate but that storage of the wastes in a deep underground repository appeared to be the best method for long-term isolation of these wastes from the biosphere.

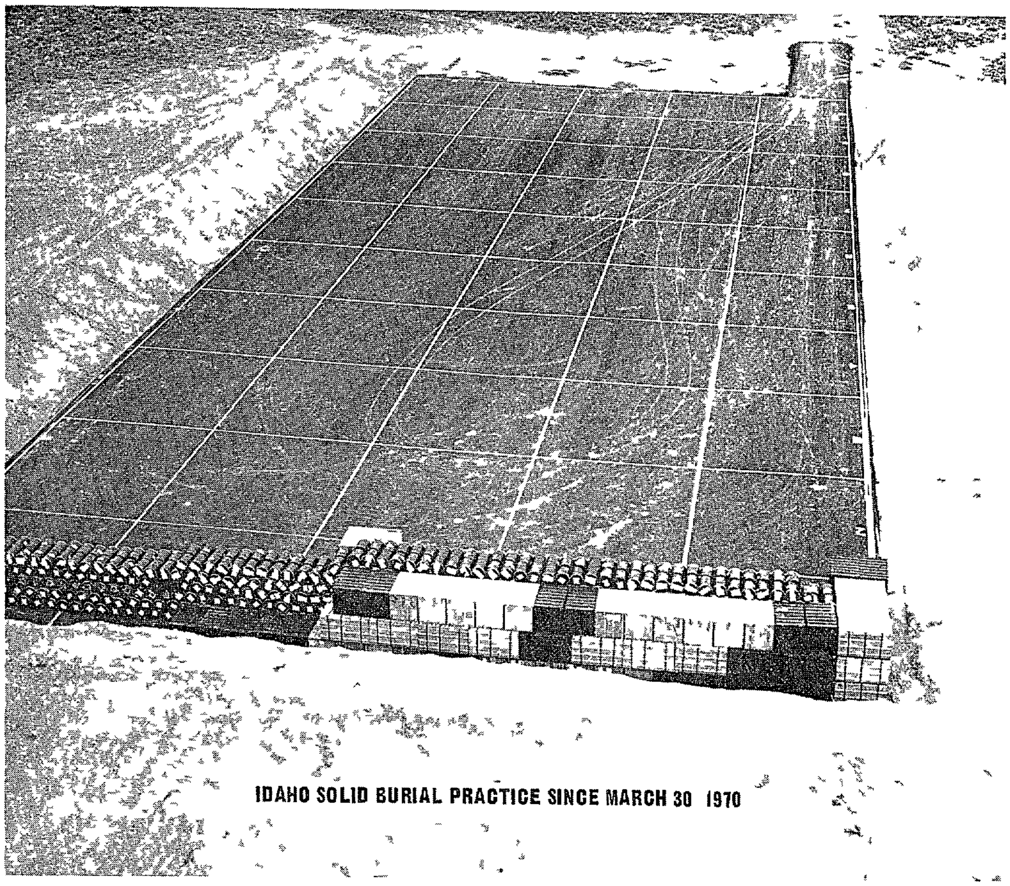
The location of the burial trenches for solid wastes containing transuranium nuclides vary from several hundred feet above the water table at Richland to such a proximity to the water table at Oak Ridge that at certain times during the year the water table intersects the wastes buried in the trenches. At Idaho the burial grounds have been inundated on occasions by the water from melting snow; however, measures were being taken to prevent future accumulation of such water on the burial grounds. AEC studies have shown that the movement of buried plutonium is minimal because of its insolubility. Illustrations obtained from AEC that show various AEC burial sites are on the following pages.

AEC expects that the Kansas salt mines will be used for long-term storage of radioactive solidified wastes and of transuranium-contaminated solid wastes. AEC believes that near-surface-land-burial practices offer no current safety hazard but that a long-term-storage facility for transuranium-contaminated solid wastes should be available to accommodate the increasing amounts of such wastes which will be generated by the nuclear industry. AEC believes also that the mines will serve as a satisfactory solution for storage of these wastes over the time periods required and will reduce surveillance requirements because of the burial depth.

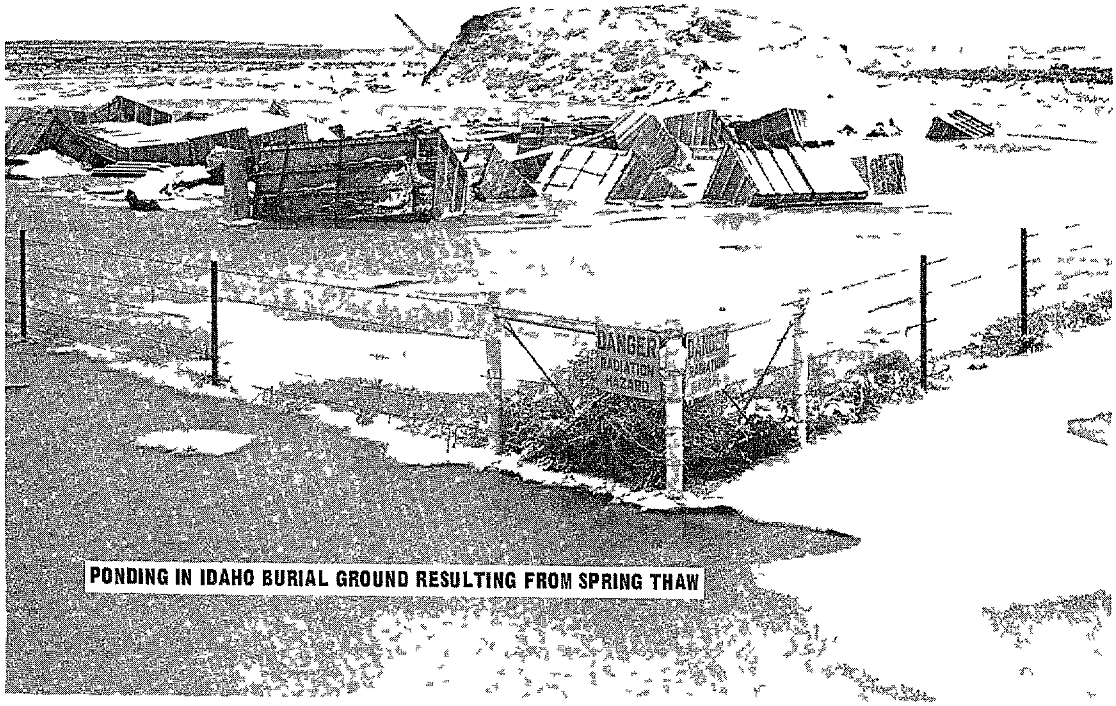
AEC is in the process of determining a definition of the level of contamination that would distinguish alpha wastes (i.e., plutonium-bearing wastes) from other radioactive solid wastes. Such a definition is necessary to estimate the volume of wastes now buried at the AEC operational sites that might be considered for transfer to the salt mines. AEC contractors' preliminary estimates indicate that to relocate all plutonium-contaminated wastes that had been buried at Richland, Savannah River, Oak Ridge, and Idaho could cost billions of dollars.


BURIAL OF RADIOACTIVE WASTE AT RICHLAND





IDAHO SOLID BURIAL PRACTICE SINCE MARCH 30 1970




PONDING IN IDAHO BURIAL GROUND RESULTING FROM SPRING THAW

# CHAPTER 4

## PRIVATE REPROCESSING PLANTS

Reprocessing of irradiated nuclear fuel, to recover usable uranium and the plutonium which has been generated in the fuel elements during their use, is a necessary part of the nuclear-fuel cycle. Economic considerations, as well as the need to conserve natural resources, dictate that private industry recover these valuable elements existing in nuclear fuel that has reached a point where it can no longer be utilized efficiently in a power reactor.

For a private firm to build and operate a fuel recovery plant, the potential operator must follow the appropriate AEC licensing procedures. The AEC licensing procedures are intended to ensure that the plant is designed, constructed, operated, and maintained in such a manner that both persons and property are protected from radiation and other health and safety hazards. The procedures include AEC reviews of the prospective plant site, the proposed process, and the applicant's preliminary safety analysis report.

Reviews of the preliminary safety analysis report are made by both the Division of Materials Licensing and the Advisory Committee on Reactor Safeguards. After these reviews, the Atomic Safety and Licensing Board holds a public hearing on the application and determines, among other things, whether the prior reviews were adequate to support the issuance of a construction permit. Both the decision of the Board to issue a permit and the permit itself are subject to review by the AEC Commissioners. Near the completion of construction of the plant, the applicant is required to submit a final safety analysis report for review by the AEC staff and by the Advisory Committee. After all questions on health and safety matters have been satisfactorily resolved, an operating license is issued.

At the time of our review, the only privately owned licensed commercial fuel-reprocessing facility where high-level radioactive wastes were being accumulated was the Nuclear Fuel Services plant. Within the next few years, that plant and three other plants are scheduled for operation, as shown below.

| Company | Throughput (metric tons) a year | Estimated date to begin operation |
|---|---|---|
| Nuclear Fuel Services, Incorporated, West Valley, New York | 300 to 900[a] | 1966[b] |
| General Electric Company, Morris, Illinois | 300 to 500[a] | 1971 |
| Allied-Gulf Nuclear Services, Barnwell, South Carolina | 1,500 | 1973 |
| Atlantic-Richfield Company, Leeds, South Carolina | 1,800 | 1976 |

[a]Future expansion capability.

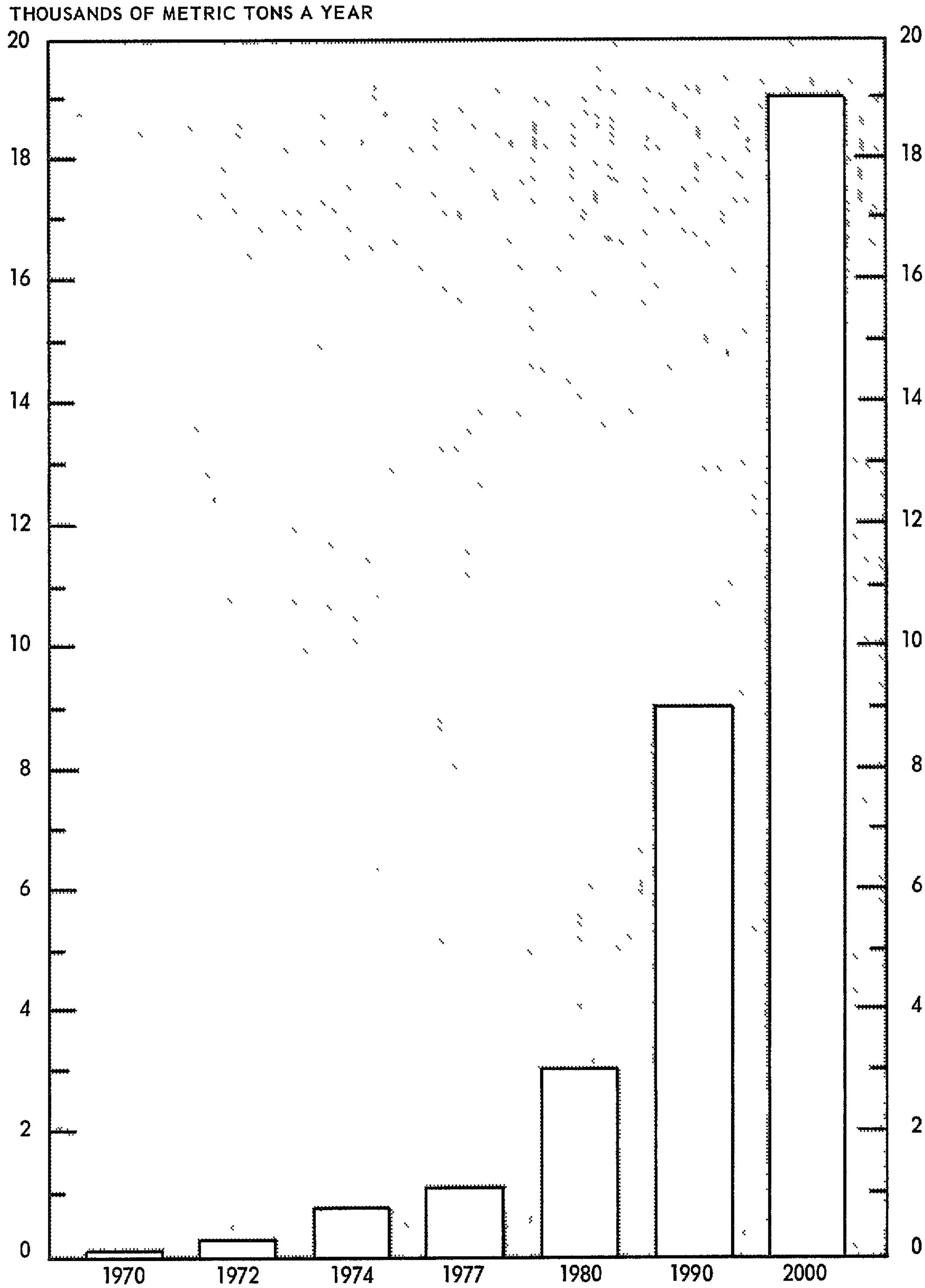
[b]Actual date.

AEC's forecast of the demand for additional reprocessing capacity in the United States for the next 30 years is illustrated in the chart on the following page.

Nuclear Fuel Services, Allied-Gulf, and Atlantic-Richfield plan to solidify their radioactive wastes following a period of interim storage in waste tanks, using methods developed by AEC. General Electric, however, plans to depart slightly from the interim storage of radioactive liquids by providing for immediate solidification of the high-level liquid wastes. In general, General Electric plans to utilize the basic AEC separation technology, but it plans also to provide for in-line solidification of high-level liquid wastes rather than initial storage of the radioactive liquid wastes in a storage tank.

AEC is developing plans for the acquisition of a site and for the construction and operation of a demonstration facility for long-term storage in the bedded-salt formations in central Kansas of solidified high-level liquid radioactive wastes and solid wastes contaminated with

# U. S. IRRADIATION FUEL FORECAST



long-lived radioactive materials. During the past decade the Division of Reactor Development and Technology and the Oak Ridge National Laboratory have made an extensive study into the possible long-term storage of high-level radioactive solid wastes in salt mines. The Laboratory developed this method of storage as Project Salt Vault during the period 1963-67.

## COMMERCIAL REPROCESSORS

### Nuclear Fuel Services

Nuclear Fuel Services plans provide for maintaining at least one spare carbon-steel tank for each three such tanks in use for storing high-level radioactive liquid wastes and one spare stainless-steel tank for each five such tanks in use for storing such wastes.

Nuclear Fuel Services has an agreement with the State of New York to accept long-term surveillance of the Nuclear Fuel Services' storage tanks in the event the plant should cease to operate. This concept of a long-term liquid-waste-storage tank farm satisfied AEC health and safety requirements because of the specific geological conditions existing at the plant site. These conditions primarily involve the nearly impermeable soil, silty till, in which the waste tanks are buried. Geological calculations submitted to AEC show that groundwater movement is extremely slow in this silty till and that it would take about 40,000 years for high-level wastes to move through this silty till from the point of storage to the nearest ravine.

During our visit to the plant site, we were advised by the company that it was providing for segregation of low- and high-level solid wastes in its solid-waste-burial practices but that it was not providing for possible retrieval of wastes known to contain transuranium nuclides because of the impermeability of the soil and the insolubility of these types of wastes We were advised by AEC that, although Nuclear Fuel Services' license did not require retrieval capability, then-current studies might result in proposed amendments to AEC regulations identifying certain plutonium-contaminated wastes as unsuitable for disposal onsite or at licensed, privately owned ground-burial facilities.

The plant's normal disposal system for low-level liquid wastes contains monitoring and mechanical provisions for minimizing the accidental discharge of high-level liquid wastes through its identification and diversion into the handling system for high-level liquid wastes before a significant amount is discharged into holding ponds for low-level liquid wastes.

General Electric

In November 1966 General Electric applied to AEC for a license to construct the Midwest Fuel Recovery Plant on a site of approximately 1,300 acres located southwest of Joliet, Illinois. We were informed by General Electric that the plant was scheduled to begin operating late in 1971.

The plant's high-level liquid wastes are to be calcined into solid form and stored under water in sealed containers, rather than accumulated in steel tanks. The plant has been designed so that no potentially contaminated liquid-effluent stream will be released. This is to be accomplished by utilizing a closed-loop system for the recovery and recycling of process water and by providing a steel-lined concrete vault for the retention of concentrated low-level liquid wastes as a slurry which will solidify on cooling into a salt cake. After treatment for removal of radioactive iodine and particulates, low-level radioactive gaseous effluents (krypton and tritium) will be released into the atmosphere through the plant's stack. For solid-waste burial, General Electric plans to utilize a stainless-steel-lined vault which will contain 9 to 10 years' accumulation of dumped fuel hardware, leached fuel hulls, and contaminated small equipment. General Electric believes that this design provides no barrier to waste retrieval and transfer to separate permanent disposal facilities.

In June 1968, General Electric's construction permit was amended by AEC to provide that

> "In the event the Commission establishes a policy and regulations for ultimate disposition of fuel reprocessing plant radioactive wastes, the Commission may require the applicant to remove from the *** [plant] for storage at a regional or national disposal site designated by the Commission the radioactive wastes particularly the high activity wastes stored inside the *** [plant]."

General Electric agreed to this amendment on the basis that it recognized the incentive for avoiding proliferation of waste disposal sites. General Electric indicated, however, that there might be instances where waste transfer operations present greater risk than immobilization and long-term protection at the interim-storage point. General Electric informed us that any decision to require retrieval and transfer of wastes should be based on evaluation of relative risk exposure, made in the light of the latest technology.

Allied-Gulf Nuclear Services

On November 7, 1968, Allied Chemical Nuclear Products, Incorporated applied for a construction permit to construct the Barnwell Nuclear Fuel Plant--a 1,500-metric-ton-per-year reprocessing plant--on a 1,706 acre site adjacent to AEC's Savannah River Plant.

In March 1970, Allied and Gulf General Atomic, Incorporated (renamed Gulf Energy and Environmental Systems, Inc.) formed a partnership for the construction and operation of the plant which was estimated to cost about $65 million. This partnership became a coapplicant with Allied and Gulf Energy under the name of Allied-Gulf Nuclear Services. Under the agreement between the two companies, Allied has the prime responsibility for design, construction, and marketing operations.

The Barnwell plant is to have controls, jointly with the AEC plant, to ensure that routine low-level radioactive effluents released into the environment from the two plants will be within established AEC limits. The high-level wastes resulting from chemical reprocessing are to be stored in acidic form in stainless-steel storage tanks which, in turn, are to be contained in stainless-steel-lined concrete vaults Allied-Gulf informed us that this method of storage had been selected for the following reasons.

--This method would allow the company to maintain the options to recover potentially valuable by-products from the wastes.

--Experience with the storage of radioactive wastes had shown that storage of an acid solution in stainless-steel tanks was more reliable than alternative storage methods

--Studies of the various alternative methods of storage of high-activity wastes had determined that the storage of acid solutions in stainless-steel tanks would be the most economical method.

--Under this method Allied-Gulf could solidify the wastes at some later date, if required by AEC to do so.

Allied-Gulf also plans to install additional stainless-steel tanks so that at all times there will be available enough tank capacity to allow any tank in use to be emptied in the event that there are problems with the tank. In addition, Allied-Gulf will install the tankage required for evaporated intermediate wastes. As these wastes are accumulated, development programs will be carried out to determine the optimum method of ultimate disposal

We were informed by AEC that in April 1970 the AEC regulatory staff, with assistance of Government consultants, completed a technical safety review of Allied-Gulf's proposed plant based on its amended preliminary safety analysis report The amended report provided information in response to questions raised during AEC's review and on Allied-Gulf's changes in the process and facility design as a result of its continuing safety review and discussions with AEC The construction permit was issued on December 18, 1970.

Atlantic-Richfield Company

In April 1969, the Atlantic-Richfield Company submitted a preliminary site evaluation report to AEC for review of the suitability of a site near Leeds for a chemical-reprocessing plant. The proposed site, which consists of approximately 2,500 acres, is located about 60 miles north of the Savannah River Plant.

After a review of the preliminary site evaluation report and a visit to the proposed site, AEC indicated that, although the report was not sufficiently complete for a formal review, the proposed reprocessing plant and site might be approved if further evaluations were made by

Atlantic-Richfield and incorporated in a preliminary safety analysis report submitted in accordance with AEC regulations.

Atlantic-Richfield submitted its application for a construction permit to AEC on October 29, 1970, for the Atlantic-Richfield Reprocessing Center. The accompanying preliminary safety analysis report included preliminary process and facility designs which indicated that Atlantic-Richfield would generally utilize the same technology as would the Allied-Gulf plant.

## RESEARCH AND DEVELOPMENT EFFORTS

In developing policies for management of radioactive wastes, AEC has concluded that liquid storage in near-ground-level tanks is acceptable only as an interim measure and has considered and investigated other methods for long-term storage. From the standpoint of safety, AEC has decided that solidification of high-level radioactive liquid wastes and storage of the solidified waste in salt formations is the best known approach to isolate this waste from the biosphere.

### Project Salt Vault

As the result of the National Academy of Sciences' recommendations, AEC initiated studies at Oak Ridge in 1959 on the disposal of high-level solid wastes. The objective of the Oak Ridge program on radioactive-waste disposal in underground formations was to demonstrate the equipment and operations necessary to carry out a safe and economical disposal of high-level solidified wastes in salt mines.

During the 1960's, AEC's research and development effort was directed toward establishing the suitability of utilizing underground salt formations for the disposal of high-level solidified radioactive wastes. The research and development studies included the demonstration of disposal of high-level radioactive solids in a bedded salt mine. As a result of these studies, AEC is of the opinion that salt disposal technology has been developed to the point where confidence can be placed in engineering a system which is practicable and which will provide assurance of long-term isolation of high-level radioactive wastes from the environment.

### Federal repository

In June 1970 AEC announced the tentative site selection for an initial salt mine repository demonstration project. Current plans include site acquisition, construction, and operation of a demonstration facility for long-term storage in mined salt vaults in central Kansas. This facility will accommodate both solidified high-level liquid wastes and plutonium-contaminated solid wastes.

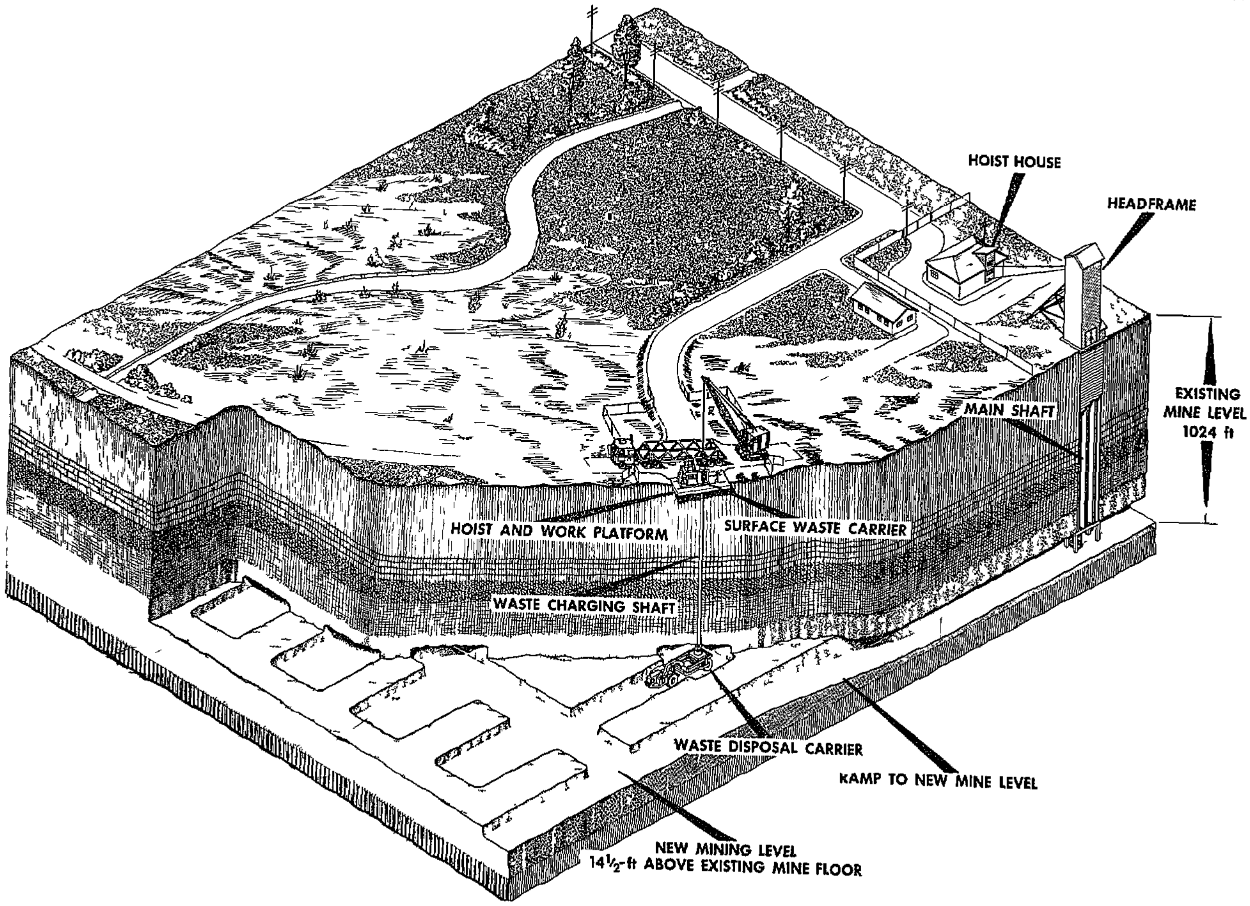
An illustration of the demonstration project provided to us by AEC is on the following page.

AEC informed us that over the next year geologic and safety studies would be conducted by the National Academy of Sciences' Committee on Radioactive Waste Management to confirm that all aspects of the operation at the selected location can be performed safely.

AEC stated that, on the basis of preliminary studies, radioactive wastes would be buried in a salt mine 1 square mile in area and 1,000 feet below the surface. AEC estimated that, on the basis of fiscal year 1971 dollars, the initial capital outlay for a facility to handle waste generated by commercial reprocessing plants would amount to $25 million and that annual operating and capital costs would amount to $150 million over the first 20 years. AEC's published policy provides that these costs be recovered from the users of the repository.

AEC estimates that preparation of a salt mine for long-term storage of radioactive wastes will require approximately 4 years after authorized funds are available. AEC plans to seek authorization for the initiation, during fiscal year 1972, of a demonstration repository to provide additional technical data and experience on operational methods and costs of long-term storage of solidified wastes which are generated by commercial reprocessing plants. AEC informed us that, although the facility was termed a demonstration repository, it anticipated that the facility would be designated as the initial Federal repository.

ORNL-DWG 63-239R2




**DEMONSTRATION OF RADIOACTIVE SOLIDS STORAGE IN SALT**

DEVELOPMENT OF REGULATIONS

In June 1969, AEC published its proposed regulations for the siting of commercial fuel-reprocessing plants and related waste management facilities and invited comments from interested parties. The proposed regulations were developed with a view to provide industry with the information needed currently to develop designs consistent with AEC requirements and with the objective of limiting the number of high-level waste disposal repositories in the country.

The proposed regulations provided that the high-level liquid wastes generated at a reprocessing plant be stored at the plant for as long as 5 years before conversion to solid form and that shipment of the solid wastes to a Federal repository be required within 10 years after generation of the liquid wastes. The regulations provided also that, upon receipt of the solid wastes at a designated Federal waste repository, the Federal Government assume physical responsibility for the material but that industry be required to pay for the costs of perpetual storage and disposal

In summary, the companies involved in reprocessing plants--Nuclear Fuel Services, General Electric, Allied-Gulf Nuclear Services, and Atlantic-Richfield--in commenting to AEC on its June 1969 proposed regulations, stated that the regulations did not clearly explain important safety, economic, and technical considerations.

Nuclear Fuel Services expressed the opinion that the proposed regulations, as stated, would be illegal when applied to existing licenses. Allied-Gulf, Atlantic-Richfield, and General Electric indicated, in general, that the regulations failed to clearly establish solidification and transportation criteria and repository charges The companies recommended that adoption of the regulations be withheld until such considerations were answered

Officials of Nuclear Fuel Services informed us that the proposed regulations, if adopted, would have a substantial adverse economic effect on their operations and would upset certain agreements and business arrangements entered into in good faith in reliance upon previously established AEC policies

In general, General Electric's planned operation of its reprocessing plant will be in accordance with the proposed regulations in that the wastes will be in a solidified form, packaged in containers, and held at its plant pending final disposal General Electric officials told us that the effect of AEC's not establishing cask and waste-container criteria had caused problems in determining and designing what General Electric considers to be an integral part of reprocessing plant's waste facilities In addition, they stated that there was a need for AEC to release background criteria for evaluating alternative disposal methods for high-level wastes and the risk-benefit relationship for onsite disposal versus offsite shipment They indicated that offsite shipping to be utilized during decontamination of reprocessing facilities upon decommissioning should be evaluated on the same basis

Although Allied-Gulf and Atlantic-Richfield had not obtained construction permits at the time AEC proposed its regulations, both companies apparently had selected, as interim methods of storage, high-level liquid-storage systems that would include the use of stainless-steel tanks We were informed by an AEC official that both companies had selected this form of storage, in part, to allow for enough flexibility to dispose of the high-level wastes as national policy warrants

On November 14, 1970, AEC published in the Federal Register revised regulations to be effective within 90 days In revising the regulations, consideration was given to the comments made by industry on the proposed regulations published in June 1969

The June 1969 proposed regulations provided that radioactive hardware resulting from operation of commercial reprocessing plants be disposed of in the same manner as solidified radioactive wastes or at a licensed Federal or State burial facility; however, this provision was not included in the November 1970 regulations We were informed by AEC that further consideration was being given to the alternative techniques for disposing of solid wastes and that regulations on these types of wastes would be forthcoming

The November 1970 regulations state that (1) recent AEC studies had identified the bases upon which repository charges might be developed and had provided preliminary estimates and (2) shipments of solidified radioactive wastes should be transported in accordance with existing regulations of AEC and the Department of Transportation

By letter dated November 11, 1970, AEC advised Nuclear Fuel Services that its operating license would be amended to provide that, in the future, high-level radioactive liquid wastes generated at its plant must be solidified and transferred to a Federal repository, in accordance with the new regulations AEC advised Nuclear Fuel Services also that, with respect to waste generated prior to the effective date of the new regulations, AEC proposed to include provisions in the amendment which would require the solidification and transfer of the wastes by a definite future date but on a schedule which would take into account the technical and economic considerations involved AEC requested a meeting with Nuclear Fuel Services to discuss the application of the new regulations and to develop a schedule of actions to be reflected in the amendment to the license

In accordance with AEC's current regulations, its regulatory divisions are responsible for licensing and reviewing the practices of commercial reprocessors, including the preparation of the wastes for transportation to a Federal repository After the commercially generated wastes are delivered to the repository, AEC's Division of Waste and Scrap Management is responsible for the material

The users of the Federal repository are to pay the Federal Government a charge which, together with interest on unexpended balances, will be adequate to defray all costs of disposal. According to AEC, following authorization of the project (expected in 1972) and the completion of the detailed repository design, a firm schedule of repository charges will be developed and published.

AEC regulations provide that high-level radioactive wastes stored at fuel-reprocessing plant sites be transferred to a Federal repository in the event a plant is decommissioned and that, for future fuel reprocessing plants, a design objective be to facilitate decontamination and removal of all significant radioactive wastes from the plant sites in the event of decommissioning. Ultimate disposal of high-level radioactive waste material will be permitted only on land owned and controlled by the Federal Government.

# CHAPTER 5

## CONCLUSIONS, RECOMMENDATION, AND AGENCY ACTIONS

In the preceding chapters, we have discussed AEC's progress in resolving its radioactive-waste management problems, as well as the difficulties that still remain with respect to both the interim and long-term storage of the wastes.

We have pointed out that AEC installations have experienced delays in improving the capability for handling interim-stored wastes at their sites and in developing long-term (centuries) storage methods for large volumes of wastes because of budgetary considerations and because long-term-storage methods have not been defined and accepted.

Although various plans and methods have been or are being developed, AEC has not established an overall coordinated plan for resolving its waste management problems and achieving its objectives at all installations. Requests for the necessary funds to implement waste management plans are made and considered on an individual-program basis.

We believe that, although AEC has assigned a high priority to radioactive-waste management, the level of effort given to the program should be increased in view of its extraordinarily complex characteristics. The problems and delays being experienced in the implementation of AEC's policies for the management of radioactive wastes are primarily attributable to a need for more definitive technology on such matters as the relative merits of various practices and proposals for interim and long-term storage.

In the past and currently, AEC management has emphasized and has given priority to the development of technology and plans with respect to AEC's weapons, production, and reactor development activities which result in the generation of radioactive wastes and to the safe containment of radioactive wastes on an interim basis. A lesser degree of management emphasis and priority have been given to the activities dealing with the long-term management of such waste.

In view of the large quantities of radioactive wastes at AEC operational sites, the continued generation of such wastes at these sites and AEC's forecasts of the relatively large volume of such wastes that will be generated by licensed fuel-reprocessing plants, the importance of developing and implementing policies and practices for long-term waste storage cannot be overemphasized. AEC recognizes that vigorous management attention must continue, to resolve existing problems and reach appropriate decisions on a reasonably timely basis and to recognize and resolve any future radioactive-waste problems as they develop.

AEC's decision in June 1970 to develop the salt mines for potential use as a Federal repository for commercially generated wastes and its announcement in November 1970 of waste management regulations for private industry are major milestones. If the development of a Federal repository proceeds on schedule and proves successful, the commercial operators should be able to avoid the waste management problems of the types experienced in the past by AEC when the lack of technology resulted in the accumulation of large volumes of high-level liquid wastes.

We believe that, to provide greater assurance that appropriate priorities are assigned to the overall waste management program, AEC should further develop and consolidate its plans for resolving waste management problems into an overall coordinated plan. Such a plan should provide the following information for each type of radioactive waste generated by both AEC and private industry at the various locations involved.

--The current status of the waste management program, both interim and long-term projects.

--The specific actions necessary to resolve existing problems and achieve acceptable waste-storage goals.

--The time frames over which these actions can be carried out.

--The estimated costs involved, by fiscal year, in carrying out these actions.

We recognize that, because of geological and other conditions at the various AEC operational and private industry sites and because of the differences in the types of wastes, the same procedures and practices may not be applicable in all cases. We believe, however, that the consolidation of such plans into a detailed coordinated plan would better serve to identify the actions needed to resolve existing waste management problems on a reasonably timely basis.

Such a plan would provide both AEC and the Congress with information regarding the required funds and, if it is not feasible to provide all the required funds, the plan would enable priorities to be established, after consideration of the relative costs and benefits of the various alternative uses that can be made of available funds. Further, by establishing specific target dates for the resolution of these problems, areas in which firm decisions are required would be highlighted and consideration could be given to the proposed solutions and actions needed to make the necessary decisions.

For instance, it is our opinion that, with such a central overview, final evaluation of the bedrock concept at Savannah River, which has been under study for about 9 years, could be expedited and thereby limit the expenditure of funds for the study of alternative solutions and minimize the need for funds to provide additional interim-storage capabilities.

## RECOMMENDATION AND AEC ACTIONS

In our May 1968 report, we recommended that:

> "*** consideration should be given to the desirability of vesting responsibility for policy making and overseeing the waste management program in a single AEC office at a level sufficiently high so that it can efficiently and economically coordinate the program and assume the authority necessary to make decisions concerning long-term storage methods, with all of the implications which such decisions encompass."

Action was taken to implement this recommendation in May 1970, when AEC established the Division of Waste and Scrap Management.

We now recommend that the Division of Waste and Scrap Management give its immediate attention to consolidating and implementing the overall radioactive waste management plan described above. We believe that, when such a plan has been established, this Division should be assigned responsibility (1) for recommending priorities for waste storage methods and for coordinating the conduct of research and development of waste storage methods to meet these priorities, (2) for recommending long-term storage methods, (3) for establishing criteria for interim storage, (4) for reviewing and evaluating the progress made by the program divisions, and (5) for coordinating matters affecting both AEC and private industry waste management practices with AEC program and regulatory divisions.

AEC officials informed us that the Division of Waste and Scrap Management had been assigned the responsibility for developing and implementing a plan for the storage of high-level radioactive wastes from licensed facilities in the proposed Federal repository in Lyons and for managing AEC's alpha, or plutonium-contaminated, wastes throughout AEC. These officials stated that the Division had been directed to coordinate the consolidation of an overall AEC plan for radioactive waste management. They stated also that the plan, which would be largely a consolidation of plans developed or being developed by various AEC divisions, offices, and contractors, was expected to be completed early in fiscal year 1972 and that it would be updated as required to reflect major needs and developments in waste management activities.

We were told that the Division had been or would be assigned the other responsibilities cited in our recommendation. The Division currently has responsibility for reviewing and approving or disapproving, in consultation with cognizant program and staff divisions, waste management plans of AEC installations. This responsibility carries with it the responsibility for monitoring progress of performance under such plans, including progress toward achieving overall AEC plans and objectives.

Under present organizational arrangements, the Division of Production will continue to have primary responsibility for the management of high-level radioactive wastes from AEC fuel-reprocessing installations, including responsibility for research and development of long-term storage methods for such wastes.

AEC advised us that the Division's activities would be conducted in accordance with the approved overall waste management plan and that its efforts to develop or improve storage methods would be coordinated with the Division of Waste and Scrap Management. Also various budget and organizational alternatives within AEC are being considered to determine the best method of ensuring that the approved overall waste management plan will be effectively implemented.

## CHAPTER 6

## SCOPE OF REVIEW

We examined into the progress made at AEC's Idaho, Richland, and Savannah River Operations Offices--located at Idaho Falls, Idaho, Richland, Washington, and Aiken, South Carolina, respectively--in the development and implementation of solutions to problems associated with interim and long-term storage of high-level radioactive wastes, as discussed in our prior report to the Joint Committee. We also made a limited review of selected aspects of the waste management activities at the Oak Ridge National Laboratory, Oak Ridge, Tennessee.

We examined also into AEC's policies and procedures for burying radioactive solid wastes at the four locations mentioned above. In addition, we considered AEC's proposed regulations for the management of liquid waste expected to be generated by the expanding civilian nuclear power industry and the technology being developed by AEC for the treatment and long-term storage of these waste materials. Our examination included discussions on current and future waste management activities with two companies which are operating, or plan to operate, private radioactive-waste reprocessing plants.

Nuclear Fuel Services, Incorporated
West Valley, New York, and Wheaton, Maryland

General Electric Company
Morris, Illinois, and San Jose, California

Our review was concerned primarily with the management of radioactive waste generated in the reprocessing of irradiated nuclear fuel. We did not examine into the waste management activities being carried out in connection with the operation of reactors, laboratories, and test facilities at the four AEC installations included in our review.

# APPENDIXES

**Congress of the United States**

**JOINT COMMITTEE ON ATOMIC ENERGY**

WASHINGTON, D C 20510

October 24, 1969

Honorable Elmer B. Staats
Comptroller General of the United States
U S General Accounting Office
Washington, D C

Dear Mr Staats

In consideration of the Committee's continuing interest in radioactive waste management activities by the Atomic Energy Commission and because of the results of the General Accounting Office Review as reported to us on May 29, 1968, we would like your Office to perform another review of this program to follow up on your prior findings However, before your Office physically starts another review, I think that you should obtain from the AEC answers to the many questions that were generated by statements in the 1968 report This will establish a common ground of what AEC has accomplished versus what they said they hoped to accomplish.

We have drawn up a tentative list of questions, which are attached. When we have the answers, we should know which areas in the waste management field require intensive examination and which areas can be examined superficially We would appreciate any comments you might care to make on our idea of how to conduct this reexamination and on the list of questions

Sincerely,

Edward J Bauser

Attachment

## QUESTIONS TO THE ATOMIC ENERGY COMMISSION ON WASTE MANAGEMENT

(Page references are in "Observations Concerning the Management of High-Level Radioactive Waste Material", GAO Report No B-164052, May 29, 1968, Secret)

1 Page 12, paragraph 1* Has AEC developed standard criteria for reserve storage capacity? On an agency-wide basis? On a specific location basis?

2 Page 12, paragraph 1 Has a decision been made on re-using tanks which have been emptied? Why would such tanks be emptied? Does "emptied" mean completely emptied or drained to a certain level? Why is the "re-using" of empty tanks questionable, what is the probable hazard?

3 Page 12, paragraph 2 Have any further data been evolved which would indicate what the true life of the Hanford tanks might be--i e , 10, 15, or 20 years?

4 Page 13, paragraph 2 What has the AEC accomplished since the last review to

a. Advance the technology of long-term storage at Richland and Savannah River?

b Arrive at "best" method for cesium and strontium solidification and encapsulation?

5 Page 14, paragraph 1 What has the AEC done with regard to organizing a single office with oversight of the entire waste management program at AEC facilities? Specifically

a Which division in the AEC has primary responsibility for waste disposal matters under the cognizance of Richland Operations Office, Savannah River Operations Office, and Idaho Operations Office respectfully? [Page 7, paragraph 1]

b Does the Division of Production (DP) coordinate through each concerned Field Office with the Contractors, or does it dictate procedures to the Field Offices, or is some other procedure used? [Page 7, paragraph 2]

c Does the Division of Reactor Development and Technology (DRDT) coordinate with DP, or does DRDT coordinate only through each concerned Field Office with the contractor? [Page 7, paragraph 4]

*Paragraph numbering starts with first full paragraph d What authority does the Division of Operational Safety (DOS) have to enforce the standards it develops? How do these standards compare to Federal Radiation Council standards? Does DOS work directly with contractors or only with Field Offices or both? [Page 7, paragraph 3]

e Do DOS, DP, or DRDT collectively or individually compare standards established for AEC facilities with standards the Director of Regulation establishes for non-AEC facilities? [Page 8, paragraph 1]

6 Page 14, paragraph 2 Is it contemplated that an AEC single-point waste management office would cover both AEC facilities and commercial/industrial/academic facilities? Would or could such an authority operate with the same set of regulations for all high level waste storage facilities?

7 Page 15, paragraph 2 Has the AEC review of its organizational structure for waste management been completed? Are reports available?

8 Page 15, paragraph 3 What reports, plans, or research has the waste management panel of the National Academy of Sciences (NAS) completed or undertaken for the AEC? Are any reports available?

9 Page 18, last paragraph Is there any significant difference in waste generated by commercial spent fuel processing plants and AEC plants processing fuel elements from AEC production reactors?

10 Page 20, paragraph 1 After 7 or more years, why is the AEC still experimenting with three or more methods of long-range, high-level waste storage?

11 Page 20, paragraph 1 Does the AEC stand behind the statement "With respect to the use of salt structures for the storage of its radioactive wastes, AEC has no present plans to store its high level wastes in this manner, even if the program is proven to be feasible because the proposed approaches appear to be adequate and additional expenses do not seem necessary at this time "? (underline is added for emphasis)

12 Page 20, paragraph 1 What were the results of the AEC salt mine storage experiment? Any reports?

13 Page 26, paragraph 4, and page 27, paragraph 3 What is the basis for the Division of Production statement (Page 27) " bedrock storage constitutes for the Savannah site a potentially safe, practical, and economical arrangement from the standpoint of providing a solution to its long-range waste storage problem " When (see Page 26) a majority of a committee of the Earth Sciences Division of the National Academy of Sciences in a 1966 report expressed strong reservations concerning the bedrock concept of waste storage and recommended that investigations be discontinued? What was the AEC justification for relying on the minority concept?

14 Page 28 Can DP justify the calculations which indicate expenditures of $100-$500 million for other than bedrock storage at Savannah River?

15 Page 40, paragraph 2 On Page 12 it is stated that tank service life could be 10, 15, or 20 years, on the top of Page 39 it is stated that carbon steel tanks might last 20 to 40 years, the second paragraph on Page 40 states "This matter is of concern because, according to AEC, there is not enough experience with the service life of existing storage tanks to reach experienced conclusions " Are any of the above listed statements correct? Which?

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON D C 20545

November 21, 1969

Mr. Dean K. Crowther
Assistant Director
AEC Audit Staff, GAO

RADIOACTIVE WASTE MANAGEMENT

Reference is made to the letter from the JCAE to the Comptroller General of the United States, dated October 24, 1969, requesting the General Accounting Office to obtain from the Atomic Energy Commission answers to questions generated by statements in the 1968 GAO Report on Radioactive Waste Management

I am enclosing for your information and further consideration, AEC's answers to the list of questions attached to the letter. I would appreciate any comments you may wish to make concerning these answers.

John A Erlewine
Assistant General Manager
for Operations

Enclosure
AEC's Answers to Questions,
w/attachments

1. **Q.** Page 12, paragraph 1 Has AEC developed standard criteria for reserve storage capacity? On an agency-wide basis? On a specific-location basis?

   **A.** As noted in the previous GAO report on waste management, the criteria for reserve storage capacity at each site were established by that site. These criteria were generally the same at all three sites in providing spare volume equivalent to one tank. In the past year the Division of Production has developed criteria for reserve storage for tank-stored wastes in conjunction with its long term isolation program which it feels can be generally applicable at all sites. The field offices have been informally instructed to implement these criteria as soon as possible. Accordingly, our budgeting and program plans have been consistent with this developed criteria which is to be formalized in the near future. Line item projects have been included in FY 1970 and 1971 budgets at RL at $10MM and similar projects at SR are being completed. The construction of new tanks at RL and SR and the conversion of waste to solid makes available tank space for increased flexibility in management of the tank farm complex to provide spare capacity in excess of the criteria defined below. In addition to safety, the tank management program as planned improves assurance of operating continuity. These criteria are

   a) At least one spare tank will be maintained in each integrated tank farm complex The spare tank must have the capacity to receive the contents of the largest tank in the farm complex. In tank farms where high heating wastes are stored, the spare tank must be capable of storing such wastes

b) In addition to the spare tank a total working freeboard volume of surge capacity of at least one year's operating requirements in each tank farm should be used in the scheduling of new tank construction. The one year lead time will provide a reasonable margin for unforeseen delays in construction of tanks.

Because nearly all of the tank-stored high-level wastes are at the Production sites, the criteria are essentially agency-wide. However, the specific implementation of the criteria at each site is dependent on the availability of the necessary facilities.

Currently, Idaho can meet the general criteria.

At Savannah River the general criteria can be met in H area with the four new double-shell tanks which are nearing completion. One tank is ready for use and the remainder will be completed within one or two months

In F area, two new double-shell tanks are under construction and are expected to be ready by the first quarter of FY 1973 The equivalent of one tank will be maintained in the F area tanks until the new tanks are completed (by evaporation of existing wastes or by transferring wastes to H area via the interarea line if necessary).

At Hanford, there are currently two single-shell spare tanks in both the Purex and Redox areas. At Purex (the only active tank farm), two new double-shell tanks which are under construction are scheduled for completion by the first quarter of FY 1971. Additional double-shell tanks are planned on a schedule to maintain compliance with the general criteria.

2. Q: Has a decision been made on re-using tanks which have been emptied? Why would such tanks be emptied? Does "emptied" mean completely emptied or drained to a certain level? Why is the "re-using" of empty tanks questionalbe, what is the probable hazard?

A: The decisions to reuse single-shell tanks must be made on a case-by-case basis. Although single-shell tanks will be available for use, our plans are to store newly generated high-heating wastes only in double-shell tanks when these tanks are available since these tanks are of improved design. All of the new tank projects provide for double-shell tanks and these tanks have been designated as the interim storage tanks in the current planning of the overall waste management program at the sites Tanks are being emptied as a result of a program to convert the waste to a solid form for safer interim or long term storage (e.g. fluidbed calcination at the Idaho Chemical Processing Plant (ICPP) and conversion of liquid wastes to "salt cakes" by repeated evaporation-crystallization operations at both Savannah River and Hanford).

The word "emptied" is used in an operational sense i.e., removing as much liquid as is possible with pumps or jets. A heel of up to 50,000 gallons might remain in the tank. Additional "emptying" would be performed on an individual basis depending upon whether the tank is to be re-used or retired from service.

Reusing of empty tanks is not necessarily questionable. Engineering studies have shown that high-heat loads can impose considerable stress upon the single-shell tanks, and as noted in an earlier answer, our plans are to use the new double-shell tanks for interim storage of high-heating liquid wastes, however, we could use these single-shell tanks that have been tested for acceptability, where necessary for newly generated high-heat wastes. There is confidence in the reuse of single-shell tanks which have stored only low-heating wastes and they are being reused to store the ITS product, new coating waste and other low-heating wastes.

The stainless steel tanks at Idaho are reusable.

3) Q: Have any further data been evolved which would indicate what the true life of the Hanford tanks might be--i.e., 10, 15 or 20 years?

A: No further data that would indicate the "true life" of Hanford tanks for liquid storage have been accumulated. However, our waste management program is removing liquid waste from tanks and storing the waste as a solid. By about 1975 essentially all but the current waste will be in solid form and all liquid waste would be considered as interim storage (5-7 years - prior to solidification) using primarily new tanks under construction at Richland These new, double-shell tanks are of improved design for safer handling of the waste and are expected to last longer, on the average, than previously constructed tanks. Thus, the waste management program places less emphasis on long life of tanks for liquid storage, also available tanks for liquid storage at Richland increase over the next few years to provide ample space capacity to support the interim storage of liquid waste. However, the long-range projection on waste tank life was a consideration at the time planning for the immobilization of wastes at the AEC sites.

4) Q: Page 13, paragraph 2: What has the AEC accomplished since the last review to (a) advance the technology of long-term storage at Richland and Savannah River? (b) arrive at the "best" method for cesium and strontium solidification and encapsulation?

A: Richland -- Technical studies have concentrated on supporting and improving operation of B plant in-tank solidification equipment. A revised analysis of the hazards associated with long-term storage of the in-tank solidification (ITS) product is in preparation. A deep hole has been drilled to explore the basalt formations under the chemical processing areas as a possible relocation alternative for the tank-stored wastes. The first results of the deep hole were encouraging but more extensive investigations would be needed to establish feasibility of the concept. The best method for cesium and strontium solidification and encapsulation have been selected, technical and engineering studies are providing support to a "design only" project in the FY 1970 Congressional budget for the facilities to solidify and encapsulate cesium and strontium.

Savannah River -- additional drilling and seismic studies have been completed to better define the geology to the southeast or the proposed site for the bedrock shaft and caverns. The data collected to date have been examined by a group of consultants who has concluded that the bedrock concept shows sufficient promise to warrant the next step, i.e. in situ exploration of the bedrock.

A copy of the consultant's report (Attachment 3) "Permanent Storage of Radioactive Separations Process Wastes in Bedrock on the Savannah River Plant Site" is attached. A "design only" project in the FY 1970 Congressional budget provides for design and site selection drilling of the central shaft for which construction funds will be sought later.

Studies have been initiated to explore alternatives to long-term bedrock storage of the Savannah River wastes.

5) Q. What has the AEC done with regard to organizing a single office with oversight of the entire waste management program at AEC facilities? Specifically.

(a) Q: Which division in the AEC has primary responsibility for waste disposal matters under the cognizance of Richland Operations Office, Savannah River Operations Office, and Idaho Operations Office, respectively?

A: The Division of Production has primary responsibility for waste management operations at the Savannah River and the Richland sites, and for the Idaho Chemical Processing Plant (ICPP) operations at the National Reactor Testing Station (NRTS). The remainder of the waste disposal operation, including the burial ground at the NRTS, is the responsibility of RDT (except for the NRF, which is under Naval Reactors). At NRTS, all liquid wastes which cannot be discharged to the surroundings are sent to the ICPP for treatment.

(b) Q: Does the Division of Production coordinate through each concerned Field Office with the contractors, or does it dictate procedures to the Field Offices, or is some other procedure used?

A. The Division of Production coordinates through the Field Offices. Program guidance is provided by the Division of Production and the Field Offices are responsible for conducting programs within the guidelines.

(c) Q: Does the Division of Reactor Development and Technology (DRDT) coordinate with DP, or does DRDT coordinate only through each concerned Field Office with the contractor?

A: The RDT and DP high level waste management programs are coordinated. This coordination has primarily been at the HQ level and has taken the form of many informal staff discussions and information exchanges in areas of mutual interest. These exchanges generally involve transmittal of special reports, attendance at meetings of joint interest (NAS committee, etc.) and, in general, keeping each other abreast of significant developments in divisional waste management efforts.

As part of this continuing dialogue, each division from time to time solicits comments and technical appraisals of significant elements in the programs of the other division. For example, RDT was requested to comment through DP on the long range waste management plans submitted by the Richland Operations Office. Similarly, the Division of Production and its contractors were asked to provide technical input and comment on the recently proposed Commission policy on the siting of commercial fuel reprocessing plants when this RDT document was in the draft form. Most recently, DP and its contractors were asked to comment on the scope of work being carried out in RDT's Waste Solidification Engineering Prototype facility before initiation of the terminal phase of this experimental program.

(d) Q: What authority does the Division of Operational Safety (DOS) have to enforce the standards it develops? How do these standards compare to Federal Radiation Council standards? Does DOS work directly with contractors or only with Field Offices or both?

A. The standards developed by DOS, when approved by the General Manager and published as Manual Chapters, are in fact directions from the General Manager and enforcement is thus a responsibility of each member of the management chain of command. In its appraisal role, DOS essentially provides an internal audit for the General Manager. DOS standards are comparable for FRC standards on those subjects on which both have published standards, however, DOS standards in either scope or detail cover subjects which the FRC has not gone into. DOS does not appraise contractors directly nor make direct suggestions or recommendations to contractors on conduct of their safety programs. DOS does maintain familiarity with contractor activities through plant visits and technical discussions, usually with Field Office safety staff in attendance, as well as through reviews of written reports.

(e) Q. Do DOS, DP, or RDT collectively or individually compare standards established for AEC facilities with standards the Director of Regulation establishes for non-AEC facilities?

A: AEC Manual Chapter 0517-025 designates the Director, DOS, as providing a central point of coordination with the Director of Regulation and other groups, committees, or agencies, in the development of codes and standards. Proposed changes in the regulatory code are usually circulated for comments of DOS and of the program divisions and Field Offices having experience in the subject areas. The Division of Materials Licensing has also requested DOS comments on safety analysis documents submitted in connection with license applications for fuel reprocessing plants. RDT, DOS, and Production all worked with REG in preparation of the proposed AEC policy on siting of fuel reprocessing plants recently published in the Federal Register for comment.

In addition to these specific responses to specific questions, the following also applies to parts b, c, and d of this question. As a result of a GM directive of November 15, 1968, each Field Office is required to develop detailed site plans for waste management and to keep these plans updated. These plans are to be submitted to Headquarters for review by OS and the programmatic divisions concerned with that site's operations.

6. Q. Page 14, paragraph 2 Is it contemplated that an AEC single-point waste management office would cover both AEC facilities and commercial/industrial/academic facilities? Would or could such an authority operate with the same set of regulations for all high-level waste storage facilities?

A. The question appears to refer to a suggestion in the GAO report rather than to AEC plans. The concept of a single office responsible for waste management within AEC was considered by the General Manager's Task Force in 1968 After review of this study, the General Manager concluded that organizational responsibilities within AEC for waste management, should remain essentially as they are assigned

We had not interpreted the GAO suggestion to include centralizing responsibility for "commercial/industrial/academic facilities" as well as AEC facilities. The only area currently under consideration where most of these interests appear to coincide is the proposed Federal repository for high-level radioactive wastes It is probable that all wastes stored at such a facility would be subject to these requirements whether from industry or from AEC installations.

7. Q. Page 15, paragraph 2 Has the AEC review of its organizational structure for waste management been completed? Are reports available?

7. A. As stated in the answer to Question 6, the General Manager's Task Force on Operational Radioactive Waste Management reviewed this subject and reported (August 1968) that reorganization was not recommended, although certain functions of the Director, Division of Operational Safety, were reemphasized. The report of this Task Force (AEC 180/43) was provided to the GAO previously

8. Q. Page 15, paragraph 3 What reports, plans, or research has the waste management panel of the National Academy of Sciences (NAS) completed or undertaken for the AEC? Are any reports available?

A. At AEC's request, the Academy Committee on Radioactive Waste Management (CRWM) devoted most of its initial year to visits to AEC installations where major radioactive waste management operations are carried out. At AEC's request the CRWM reviewed and commented upon the AEC's proposed policies on siting of reprocessing plants. Copies of these comments have been given to GAO and have been sent to the JCAE

The CRWM is currently preparing a report to AEC relating to its activities to date When received, the report will be made available to GAO and JCAE.

9) **Q:** Page 18, last paragraph. Is there any significant difference in waste generated by commercial spent fuel processing plants and AEC plants processing fuel elements from AEC production reactors?

**A:** The wastes from the commercial plants will have higher radioactivity content, and higher heat generation, per unit volume than the corresponding AEC plant wastes, but the relative abundance of the different radionuclides to one another will be similar. The commercial wastes before solidification will have less volume per ton of fuel than AEC production wastes, due to more advanced processes and physical removal of claddings as solids. Background material on this general subject is being prepared for use of the GAO staff.

10. Q. Page 20, paragraph 1 After 7 or more years, why is the AEC still experimenting with three or more methods of long-range, high-level waste storage?

A. There is no single best solution for long-range, high-level waste storage which will take into account the varieties of wastes, differences in composition and particular environmental conditions at each of the AEC sites storing radioactive waste. Therefore, each site's waste management program for long-term storage of its radioactive wastes has taken a different approach suitable to the particular situation at that plant or site. Idaho is using a fluidized-bed calciner. Richland is employing the waste fractionation in-tank solidification and Savannah River is considering caverns mined in the bedrock under the site The attached article (Considerations for Long-Term Waste Storage and Disposal at U.S AEC Sites," Attachment 1 ), goes into the reasons in more detail Also, additional methods for waste management are under development which would be better suited for licensed commercial fuel reprocessing operations and to serve as backup to an AEC operation provided any one of the approaches currently being taken is not found to be acceptable.

11) Q: Page 20, paragraph 1. Does the AEC stand behind the statement "With respect to the use of salt structures for the storage of its radioactive wastes, AEC has no present plans to store its high level wastes in this manner, even if the program is proven to be feasible because the proposed approaches appear to be adequate and additional expenses do not seem necessary at this time?"
(underline is added for emphasis)

A The AEC is studying the feasibility of storing its high-level wastes in salt structures but only as alternatives to its current plans. Because of the large volumes of wastes stored at the Commission's chemical processing plant sites, the Commission is seeking long-range high-level waste management solutions which will leave the wastes at these sites. Solidification of the AEC's wastes and shipment to salt structures for long-term storage would be a very expensive alternative which may well cost as much as $1 billion to implement. The programs that the AEC is examining should cost only a fraction of the cost of removing the wastes from the production sites.

12. Q. Page 20, paragraph 1 What were the results of the AEC salt storage experiment? Any reports?

A. The operation of Project Salt Vault (a demonstration disposal of high-level radioactive waste solids in a Lyons, Kansas, bedded salt mine, using Engineering Test Reactor fuel assemblies in lieu of actual solidified wastes) has successfully demonstrated waste-handling equipment and techniques similar to those required in an actual waste disposal operation. A total of about 4 million curies of fission product activity in 21 containers, each having an average of about 200,000 curies was transferred to the disposal facility in the mine and back to the NRTS at the end of the test During the 19-month operation of the radioactive phase of the demonstration, the average radiation dose to the salt over the length of the fuel assembly container holes was about $8 \times 10^{8}$ rads, and the peak dose was about $10^{9}$ rads. The infinite dose to the salt over the lifetime of the facility is expected to be on the order of $10^{10}$ rads. As anticipated from the Laboratory studies, no significant effects due to the radiation were detected.

Project Salt Vault has indicated that the in situ heat transfer properties of salt are sufficiently close to the values determined in the laboratory that confidence can be placed in theoretical heat transfer calculations. Calculations to date have generally been approximate and on the conservative side, but the knowledge now exists to permit more precise calculations to be made by means of more complex computer programs.

The most significant finding in the field tests regarding the effects of heat on salt behavior is that the insertion of heat sources in the floor of a mine room produces a thermal stress whose effects are instantaneously transmitted around the opening (to the pillars and roof). These stresses produce increased plastic flow rates in the salt.

The combined field and laboratory tests have provided sufficient information on these salt flow characteristics to allow the development of both general and specific empirical criteria for the design of a disposal facility in almost any bedded salt deposit. These criteria are necessary for a detailed engineering design of an actual disposal facility.

To summarize, it may be said that most of the major technical problems regarding disposal in salt have been resolved. The feasibility and safety of handling highly radioactive materials in an underground environment have been demonstrated The stability of the salt under the effects of heat and radiation was shown, as well as the capability of solving minor structural problems by standard mining techniques. The data obtained on the creep and plastic flow characteristics of the salt will make it possible to arrive at a suitable mine design for an actual disposal facility. The final report on Project Salt Vault will be issued during this fiscal year.

13) Q: Page 26, paragraph 4, and page 27, paragraph 3 What is the basis for the Division of Production statement (page 27) "...bedrock storage constitutes for the Savannah site a potentially safe, practical, and economical arrangement from the standpoint of providing a solution to its long-range waste storage problem." when (page 26) a majority of a committee of the Earth Sciences Division of the National Academy of Sciences in a 1966 report expressed strong reservations concerning the bedrock concept of waste storage and recommended that the investigations be discontinued? What was the AEC justification for relying on the minority concept?

A: The NAS Committee referred to, in its 1966 report, stated that in situ examination of the bedrock caverns would provide the best evidence that caverns could retain the radioactive wastes. However, a majority of the committee felt positive results from continued studies would be unlikely and recommended their termination, while a minority felt additional studies were needed before a decision was made to abandon the concept. The AEC decided to perform additional studies because the differential in cost between bedrock storage and the alternatives justified expenditure of funds to obtain this information. The bedrock project consultants engaged by duPont (see reference 3) have examined all of the data available and have concluded in situ exploration of the bedrock is justified and there is a high probability of producing evidence to warrant completion of the entire project. Although this panel of consultants does not represent the NAS, each consultant is individually a member of the NAS.

14) Q: Page 28 Can DP justify the calculations which indicate expenditures of $100-500 million for other than bedrock storage at Savannah River?

A: The attached article ("A Look at Long Range Waste Management Costs at USAEC Sites" Attachment 2) provides an estimate. These estimates are in 1964 dollars and escalation and subsequent experience and information would increase these costs significantly. However, the relative magnitudes and ratios of the alternatives probably would not be changed. The duPont consultants' report (Attachment 3) also povides a similar estimate of $334 million. It should be noted that these are only preliminary estimates which have been made without benefit of process development studies related to adapting calcination processes to the specific wastes at Savannah River and detailed engineering studies to better define the facility requirements. The actual costs may exceed the estimates.

15) Q: Page 40, paragraph 2: On page 12 it is stated that tank service life could be 10, 15, or 20 years, on the top of page 39 it is stated that carbon steel tanks might last 20 to 40 years, the second paragraph on page 40 states: "This matter is of concern because, according to AEC, there is not enough experience with the service life of existing storage tanks to reach experienced conclusions." Are any of the above-listed statements correct? Which?

A: As covered by the AEC's answer to question #3, the waste management program does not place long term reliance on storage of liquid waste in tanks. Since the AEC is moving away from long term liquid storage and with the projected space storage capacity, the service life of waste tanks is not the same critical factor in the program as it would have been had AEC continued with liquid storage.

The service life values presented in the GAO report are only estimates based mostly upon measured corrosion rates and the allowance (additional wall thickness) made for corrosion in the tank design. The service life as used by the AEC and its contractors is an estimated "average" value used in planning for replacement of tanks in the event extended interim storage of liquid wastes is contemplated. Because of the small number of tanks that have been constructed to handle, current waste, sufficient statistical experience must await the accumulation of a larger number of tank years. Because of the immobilization program, the tank years to be used in any statistical analysis would increase slowly with time. As noted above, this information is now not essential to the AEC waste management program.

**Congress of the United States**
**JOINT COMMITTEE ON ATOMIC ENERGY**
WASHINGTON, D C 20510



December 15, 1969

Honorable Elmer B. Staats
Comptroller General of the
United States
U S General Accounting Office
Washington, D C

Dear Mr Staats

Our letter of October 24, 1969 requested that the General Accounting Office perform a follow-up review of the radioactive waste management activities of the Atomic Energy Commission. As indicated in our letter, we considered that the areas to be reviewed, and the depth of review, should be predicated upon the AEC's response to the series of questions generated by your report of May 28, 1968 on waste management The meeting on December 8, 1969 of the Joint Committee staff with personnel from GAO and AEC did much to clarify AEC progress and plans for radioactive waste management by the Government

It appears to us that any radioactive waste management and control programs will, in the near future, involve comprehensive government-industry cooperation, particularly if the AEC plan for a 5-year maximum storage period at non-U S Government facilities goes into effect While the GAO review will be of Government facilities and plans, possible future relationships to the civilian nuclear program of waste management should be kept in mind.

As part of the review, we would like the GAO to consider examining the following aspects of the AEC's program

1. The manner in which the AEC organizations responsible for waste management activities discharge their responsibilities with respect to operations and research and development using the AEC field offices and contractors

2. The effectiveness of programs for developing, evaluating, and appraising methods of interim and long-term storage for waste generated by AEC and commercial facilities.

3. The status of research and development programs being carried out by AEC to develop a means for long-term waste storage and reasonableness of established objectives.

As stated previously, you may desire, while conducting this review, to consider the AEC's proposed policy statement dealing with the siting of commercial fuel reprocessing plants and related waste management facilities and to determine the positions taken by some commercial firms who are now or will be dealing with high-level radioactive wastes.

Your cooperation in these important matters will be greatly appreciated.

Sincerely yours,

Edward J. Bauser
Executive Director

BEST DOCUMENT AVAILABLE

# PRINCIPAL MANAGEMENT OFFICIALS OF THE ATOMIC ENERGY COMMISSION RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

| | Tenure of office | |
|---|---|---|
| | From | To |
| CHAIRMAN<br>Glenn T Seaborg | Mar. 1961 | Present |
| GENERAL MANAGER<br>R. E. Hollingsworth | Aug. 1964 | Present |
| DIRECTOR OF REGULATION<br>Harold L Price | Sept. 1961 | Present |
| ASSISTANT GENERAL MANAGER FOR OPERATIONS<br>John A. Erlewine | Dec. 1964 | Present |
| ASSISTANT GENERAL MANAGER FOR PLANS AND PRODUCTION<br>George F. Quinn | Aug. 1961 | Present |
| ASSISTANT GENERAL MANAGER FOR REACTORS<br>George M. Kavanagh | Jan. 1966 | Present |
| ASSISTANT GENERAL MANAGER FOR RESEARCH AND DEVELOPMENT<br>Spofford G. English | Aug. 1961 | Present |
| DIRECTOR, DIVISION OF PRODUCTION<br>Frank P. Baranowski | Oct. 1961 | Present |

| | Tenure of office From | To |
|---|---|---|
| DIRECTOR, DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY | | |
| Milton Shaw | Dec. 1964 | Present |
| DIRECTOR, DIVISION OF OPERATIONAL SAFETY. | | |
| Martin B. Biles | Nov. 1966 | Present |
| DIRECTOR, DIVISION OF WASTE AND SCRAP MANAGEMENT | | |
| Henry A. Nowak | Aug. 1970 | Present |
| DIRECTOR, DIVISION OF MATERIALS LICENSING | | |
| John A. McBride | Jan. 1965 | May 1970 |
| Lyall E. Johnson (acting) | May 1970 | Present |
| FIELD OFFICE MANAGERS. | | |
| Idaho Operations Office | | |
| William L. Ginkel | Nov. 1963 | Present |
| Oak Ridge Operations Office | | |
| S. R. Sapirie | Feb. 1951 | Present |
| Richland Operations Office | | |
| Donald G. Williams | July 1965 | Present |
| Savannah River Operation Office. | | |
| Nathaniel Stetson | Dec. 1965 | Present |

U S GAO Wash , D C