THE NATIONAL WASTE TERMINAL STORAGE PROGRAM

C. D. Zerby

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MASTER

Testimony at the South Dakota Interim Legislative
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**UNION
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OFFICE OF WASTE ISOLATION
OAK RIDGE, TENNESSEE

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THE NATIONAL WASTE TERMINAL STORAGE PROGRAM

by

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Testimony at the
South Dakota Interim Legislative Natural Resources Committee
Rapid City, South Dakota

October 7, 1976

Mr. Chairman and Members of the Committee: I appreciate the opportunity to appear before you to assist in the discussion of deep geologic disposal of nuclear waste.

INTRODUCTION

In my presentation, I will provide an overview of the national geologic disposal program and then turn to that portion of the program that concerns the state of South Dakota. This will be followed by a presentation on the status of solidifying high-level waste. I hope in these presentations we answer the questions that you have. If not, we will attempt to answer them at the end of the presentations or at a later time when we have the information available.

NUCLEAR POWER PERSPECTIVE

At the outset I would like to put nuclear energy in perspective. The current status of nuclear reactors in the United States is presented in Fig. 1. There are currently 60 reactors in operation, an additional 93 are under construction, and 84 are in the planning stage. The current operating reactors generate 41 GWe or about 8% of the total electrical

power being produced. When all the reactors shown in Fig. 1 are in operation between 1985 and 1990, the total nuclear electrical generating capacity will be 237 GWe or about 25% of the total. This is put into perspective in Fig. 2 which shows the electrical power forecast by the Office of Planning and Analysis of ERDA. While the total power capacity will grow by a factor of three from 492 GWe in 1975 to 1,550 GWe in 2000, the electrical power produced by nuclear facilities will increase by a factor of five, increasing from 8% of the total in 1975 to 40% of the total in 2000. This is a significant increase and indicates the importance of nuclear power to this nation.

The major portion of the electrical power not produced by nuclear sources will be generated by coal. Fig. 3 shows the history of coal production from 1965 through 1974. As you can see, the level of production has remained relatively constant at about 500 million tons per year. By 1985 the current resources will have been partially depleted (the solid bar) and new resources producing approximately 600 million tons per year will have to be developed. In other words, to meet our electrical power needs even with nuclear power, the production rate of coal has to more than double. The question is, what additional coal production is required if there is no nuclear power? In this case an additional 409 million tons of coal per year must be mined to meet the expected electrical demand. This means a three-fold increase in production of coal would have to be achieved. Obviously, this would place a significant if not impossible burden on the coal industry.

The projected nuclear power growth shown in Fig. 2 assumes that the Light Water Reactor (LWR) will be the predominant reactor utilized through

the year 2000. The Liquid Metal Fast Breeder Reactor (LMFBR), the only other type expected to be utilized during that period, will make a minor contribution of only 10% of the nuclear produced electrical power in the year 2000.

The full light water reactor nuclear fuel cycle is shown in Fig. 4, although it is incomplete at this time. The cycle starts with the mining and milling of uranium ore which is converted to UF_6 and then enriched in concentration of ^{235}U prior to conversion into a fuel and fabrication into a fuel element. After generating power in the reactor, the spent fuel element is placed in a storage pool until it is ready for reprocessing. In the reprocessing step, the uranium remaining in the fuel element is recovered and returned to the fuel cycle and the plutonium produced while in the reactor is removed and converted into a fuel. The nuclear waste from reprocessing which includes the fission products and fuel element cladding hulls is then disposed of as waste in a geologic disposal facility.

At the present time, the fuel cycle is not complete since no commercial reprocessing plant is in operation at this time. However, one plant is under construction at Barnwell, South Carolina, and one or more are being planned at other locations. In addition, no geologic disposal facility exists although there is an extensive program to develop such facilities under the National Waste Terminal Storage (NWTS) program. One of the objectives of this presentation is to provide you with information about that program.

HISTORY

The geologic disposal of radioactive waste is not a new subject. It has actually been under active study for over 15 years. In fact, as early as 1957, the National Academy of Sciences-National Research Council advisory

committee suggested burial of solid radioactive wastes in bedded salt deposits as the best of the many methods it had considered.¹ Shortly after that, work started at the Oak Ridge National Laboratory (ORNL) on the study disposal in salt. This led to an underground vault test in a bedded salt mine at Lyons, Kansas, in which simulated waste was placed in the geologic formation in a thoroughly instrumented test. Although further development of the Kansas test into a pilot plant facility was not pursued, work continued toward identification of other rock units within the United States which would be acceptable for terminal storage of radioactive waste.

In the early 1970s, the Atomic Energy Commission (AEC) authorized Atlantic Richfield Hanford Company (ARHCO) to design a Retrievable Surface Storage Facility (RSSF) to receive and store high-level radioactive waste on a schedule compatible with the then-planned operating schedule of the commercial nuclear reprocessing industry. The RSSF was considered an interim solution for storage of waste until a permanent geologic terminal storage facility could be developed. The schedule for constructing the nuclear facilities has now changed and allows several years until a final repository is needed, and there is now time to implement a full-scale geologic terminal storage program. As a result, the RSSF approach has been placed in a standby status as another alternative if needed.

As a result of the earlier geologic study work, a confirmation study location has been identified in southeast New Mexico in the bedded salt of the Permian Basin. At that location, which is about 30 miles east of

¹ Disposal of Radioactive Waste on Land, Publ. 519, National Academy of Sciences-National Research Council, Washington, D. C., 1957.

Carlsbad, New Mexico, the Waste Isolation Pilot Plant (WIPP) is to be developed for terminal storage of low level and intermediate level ERDA nuclear waste generated in the defense program. The facility is also being designed so it is not incompatible with the disposal of high level waste. This will permit optional use of the facility for commercial waste disposal should this be required in the future. The WIPP facility is currently independent of the commercial terminal storage program.

PROGRAM AND REPOSITORY

In early 1976 the Energy Research and Development Administration (ERDA) announced a greatly expanded program in the area of management of nuclear waste. At that time they created the National Waste Terminal Storage (NWTs) program and placed the lead responsibility for the program at the ERDA Oak Ridge Operations Office. A new Office of Waste Isolation (OWI) in Union Carbide Corporation-Nuclear Division (UCC-ND) was then assigned the responsibility for program management of the activity.

The objective of the NWTs program is:

To provide facilities in various deep geologic formations at multiple locations in the USA which will safely dispose of the commercial radioactive waste which must be delivered to a Federal Repository for terminal storage.

An artist's concept of a Federal Repository in a bedded salt formation is shown in Fig. 5. This is similar to the design expected in all types of geologic formations. Typically, the facility would consist of a large number of excavated rooms located several hundred feet below the surface of the ground. On the surface would be located receiving and handling facilities for containerized waste which would be delivered by truck or

rail. Shafts would connect the receiving facilities to the mine for delivery of the containerized solidified waste to transporter vehicles which would move the waste to its point of disposal. In the case of waste with high levels of radiation, the canisters would be lowered into vertical holes in the floor of a room and the hole would be plugged for radiation protection. In the case of low-level waste, the containers would be stacked for disposal. The areas associated with the Federal Repository are shown in Fig. 6. The surface facilities would occupy approximately 100 acres and be the only visible evidence of the Repository. The excavation for a full-scale facility might occupy a land area with a radius of about one mile which would include 2,000 acres. Surface areas above the excavation, but outside the fence around the surface facilities, might be leased for general use. Surrounding the central excavated area would be an outer controlled area of approximately 16,000 acres in which mining operations and deep drilling would be controlled to avoid any compromise of the safe operation of the Repository. Surface areas over the outer controlled area would not be restricted from normal activities.

WASTE FORMS AND ESTIMATES

Currently, the only regulations requiring delivery of commercial waste to a Federal Repository are contained in Title 10, Code of the Federal Regulations (CFR), Part 50. These regulations refer to licensing of production and utilization facilities, and Appendix F refers to siting reprocessing and related waste management facilities. In brief, Appendix F requires that: (1) a fuel reprocessing plant's inventory of high-level liquid

radioactive wastes^a will be limited to that produced in the prior five years; (2) high-level radioactive waste shall be converted to a dry solid and placed in a sealed container prior to transfer to a Federal Repository; and (3) all high-level wastes shall be transferred to a Federal Repository no later than 10 years following separation of fission products from the irradiated fuel.

Other requirements for shipment of waste to a Federal Repository may be included in changes to Title 10 CFR, Part 20. Regulations in 10 CFR 20 pertain to Standards for Protection Against Radiation. Current proposed changes relate to transuranic waste disposal and will require that waste with contamination levels as low as 10 nanocuries of transuranic elements per gram of waste must be transferred to ERDA for storage as soon as practicable but within five years after its generation. These regulations imply that if reprocessing plants are put into operation, then high-level waste will be delivered to the Federal Repository as well as waste contaminated with some minimum level of transuranic waste. The present design plans for the repository provide for disposal of four types of containerized waste defined as follows:

Waste Forms

High-Level Waste - Solidified composites of all the liquid waste streams arising from the reprocessing of spent fuels. These wastes contain more than 99.9% of the nonvolatile fission

^aHigh-level liquid wastes means those aqueous wastes resulting from the operation of the first-cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for processing irradiated reactor fuels.

products, 0.5% of the uranium and plutonium, and all the other actinides formed by transmutation of the uranium and plutonium in the reactor.

Cladding Wastes - Solid fragments of Zircaloy and stainless steel cladding and other structural components of the fuel assemblies that remain after the fuel cores have been dissolved. These fragments are compacted to 70% of theoretical density. In addition to neutron-induced radioactivity, the cladding waste contains 0.05% of the actinides and 0.05% of the nonvolatile fission products in the spent fuel.

Intermediate-Level Transuranic Wastes - Those solid or solidified materials (other than high-level and cladding wastes) that contain long-lived alpha emitters at concentrations greater than 10 nCi/g, and have typical surface dose rates between 10 and 1000 millirems/hr after packaging due to fission-product contamination.

Low-Level Transuranic Wastes - Those solid or solidified materials that contain plutonium or other long-lived alpha emitters in known or suspected concentrations greater than 10 nCi/g, and yet have sufficiently low external radiation levels after packaging that they can be handled directly.

These definitions are taken from the paper by Blomeke and Kee.²

For reference, the accumulated quantities of these commercial wastes to be

²J. O. Blomeke and C. W. Kee, "Projections of Wastes to be Generated," International Symposium on the Management of Wastes from the LWR Fuel Cycle, July 11-16, 1976.

delivered to a Federal Repository through the year 2005 are presented below:

<u>Waste Type</u>	<u>Accumulated Volume to the Year 2005 (1000 cu ft)</u>
High Level	221
Cladding	326
Intermediate-Level Transuranic	1,651
Low-Level Transuranic	4,940

For reference, Figs. 7-10 are included which show the growth of the accumulated commercial waste to shortly after the turn of the century.

The estimates of the generation of commercial nuclear waste presented above assumes reprocessing plants will be approved for operation in the United States. If they are not approved, then, in effect, the so-called throw-away cycle will come into existence and the complete spent fuel elements must be disposed of. In this case, the Federal Repository will be designed to dispose of spent fuel elements instead of the waste forms indicated above.

It is important to note at this point that should the nuclear industry be terminated today for some unforeseen reason, there will still be a need to dispose of all the existing exposed fuel elements in a geologic terminal storage facility. Consequently, we cannot simply ignore the disposal problem — we have to bring it to a satisfactory resolution.

MULTIPLE FACILITY SCHEDULE

As pointed out in the objective, the general plan for the NWTs program calls for the eventual construction of facilities for terminal storage in various geologic formations at multiple locations in the United States.

This approach incorporates a number of advantages into the program. These include: (1) feasibility of a timely operation of a terminal storage facility is increased because of the simultaneous and parallel activities, (2) a retrievability concept for storage of waste becomes practical because other facilities are available to receive the waste should it be necessary to move it from one of the facilities for any reason, (3) it will make it possible for more than one site to serve the country as a terminal storage facility so no one location need bear the burden for the entire United States, (4) reduced waste transportation costs are possible if more than one facility is used since they will be dispersed around the country, and (5) it eliminates concern regarding possible Federal Government reluctance to abandon possible sites after significant expenditure since other facilities will be available.

At this time the plans of the NWTS program call for construction of six terminal storage facilities as shown in Fig. 11. In that figure the solid triangle indicates the time geologic field work starts with the objective of identifying repository sites in the rock unit being investigated. Earlier work which will be accomplished prior to the search for sites is not shown on this schedule.

It is the plan for the program to locate the first two facilities in salt formations and the remaining facilities in other types of formations. All of these facilities will be dispersed around the country. The schedule in Fig. 11 shows the first two repositories receiving waste in the middle of 1985. The next set of two facilities will start operation two years later with the remaining two following at intervals of two years. Licensing by NRC will occur for limited scope of operation at the time the

repository first goes into operation. These restrictions will be removed as soon as approved by NRC.

A more detailed plan for the first two facilities is presented in Fig. 12. These will be located in salt formations. The first phase shows identification of acceptable sites for the first two repositories will not occur until near the end of FY 1978. In the second phase, although purchase of land and long lead items are shown, it should be noted that land purchase will not start until the entire review process for site selection has been completed. Phase 5 shows that hot operation of repositories 1 and 2 with actual radioactive waste will not occur until mid-1985 — almost nine years from the present time. The last phase shows safety studies and environmental studies continuing through the whole initial phase of the operating program.

DEVELOPMENT SEQUENCE

Although the sequence for developing a terminal storage facility may differ slightly from one geologic formation to another, the generalized sequence can be characterized as having six distinct steps as follows:

1. Identification of Formations of Interest
2. Reconnaissance Surveys
3. Area Studies
4. Detailed Confirmation Studies
5. In Situ Tests
6. Repository Operations

Although the six steps are distinct, it is not necessary that they all occur in sequence. For example, the in situ tests could proceed in

parallel with other geologic studies. A brief description of the steps is given below.

Identification of Formations of Interest

In the process of identifying formations of interest, a review is made first which is based solely on the general knowledge of the geologic properties and/or fundamental properties of the rock type involved. If the review is promising, a reconnaissance survey would be undertaken. This step has already led to the identification of salt, argillaceous, crystalline rock, and carbonate rock formations as formations of interest. However, others may also be identified in the future.

Reconnaissance Survey

The purpose of the reconnaissance survey would be to collect all the available data on those properties and characteristics of the formation needed for waste disposal considerations. This information provides a regional evaluation of the potential for utilization of the formation for waste disposal and may include (1) structure, stratigraphy, depth, and thickness, (2) hydrology, (3) mineralogy/petrology, (4) natural resources, and (5) general surface characteristics. Based upon the information compiled at this stage, the prospects for the formation are evaluated and reviewed and a number of smaller regions are identified for further geologic area studies.

Area Studies

The geologic area studies that follow the reconnaissance survey are designed to develop new and specific data in the areas of interest. These studies include (1) core drilling at a density of perhaps 6 to 10 holes per 1,000 square miles to obtain adequate definition of the important

subsurface characteristics of the formation, (2) field geologic mapping, (3) hydrologic studies, (4) geophysical surveys, and (5) other geologic studies. It would be appropriate to note at this point that environmental assessments are usually required by each state in order to obtain drilling permits. In the NWTS program we will, of course, prepare an environmental assessment for each drilling operation. This is in compliance with ERDA regulations which conform to the National Environmental Policy Act of 1969. Upon completion of these studies, the suitability of the area is again reviewed and if it still appears promising, a few specific locations will be identified for even more detailed confirmation investigations. There will be extensive reviews at this point involving all review groups that have been established. The selection by OWI and ERDA of specific locations for more detailed confirmation investigations and the final selection of repository sites will be firmly based on all these reviews as well as public comments obtained during public progress reports.

Detailed Confirmation Studies

The detailed confirmation studies are directed toward specific locations of perhaps 5-10 square miles each. The investigations involve primarily the drilling and testing of four or more core holes at each location, plus the continuation of any specific geologic studies for which the previous results are inadequate to evaluate the suitability of the location. The results of this phase of the investigation would be to determine which locations fully qualify for consideration as repository sites.

In Situ Tests

Once the formation is identified as a possible candidate for waste disposal, a set of in situ experiments will be conducted in parallel with other geologic studies ranging from simple electrical heaters placed in holes in exposed surface outcrops of the formation to extensively instrumented vault tests in excavations especially constructed at the expected depth of the repository. In general, the vault tests are constructed to permit tests with both electric heaters and/or canisters of simulated waste which are removed at the conclusion of the experiment. They provide extensive information on the physical behavior of the rock, the waste canister, as well as the stability of the underground layout. In situ tests have already been completed for one bedded salt formation but still have to be completed for other formations of interest.

Repository Operations

After adequate review, a repository site will be selected and a repository will be constructed which will meet NRC licensing requirements. Although these requirements are under study by NRC at this time, it is expected that the initial repository operations might be restricted under the license to require waste emplacement in a retrievable mode, limitation in the size of the facility or the amount of waste that can be stored, and special testing or monitoring requirements to confirm the adequacy of the design. Because of the limitation of size, the excavations of the underground repository would only be a portion of the full-scale facility. When sufficient data have been gathered to justify removal of the constraints contained in the NRC license, the facility will be expanded to full-scale, retrievability will be abandoned, and the fully utilized rooms will be backfilled and sealed.

REVIEW GROUPS

It is planned that a number of review groups will also be created to help in the decision process during the sequence leading to creation of the operating repositories. These review groups will include:

1. A Geologic Review Group reporting to the Director of OWI, consisting of senior geologist, hydrologists, and other appropriate experts to review the entire geologic program on a continuing basis.
2. Basin or Regional Review Groups will be created consisting of experts knowledgeable about each particular basin or region in which field operations are expected.
3. Federal-State Review Groups will be created consisting of representatives of agencies of the federal and state governments and other organizations who would have responsibility for or interest in some aspect of the NWTs program.

In addition, the public will also become involved in the reviews during public information meetings that will periodically be held in the regions where operations will be under way.

Site Screening and Selection

The site screening and selection process is depicted in Fig. 13. It shows that there will be a number of geologic study areas identified in all the formations under consideration. The actual number will be dependent on the results of the reconnaissance surveys in each case. Although six are shown in Fig. 13, a much larger number will actually be studied. Within each study area, a number of detailed confirmation study locations will be identified. In some cases, it is possible that no study locations

will be selected depending on the results of the earlier work. It is expected that there may ultimately be as many as 30 to 40 of these study locations. Finally, from all of the study locations, the final repository sites will be selected after careful consideration and review.

Although Fig. 13 shows all the screening and selection work proceeding in parallel, this will not actually be the case. Most of the steps will be staggered with the work on the formations other than salt delayed to a later time. Even within a given formation, such as bedded salt, the process will be staggered and the timing sensitively dependent on the state of geologic knowledge about the various parts of the formation.

Site Selection Factors

At this time, the factors that must be considered in selecting a site for a repository have not been adopted by OWI or ERDA. They are under active study within OWI and in the near future we plan to award a contract (or contracts if necessary) to develop recommendations in this regard that can be considered by those involved in the decision process of selecting sites.

Preliminary site selection factors have been developed in the past for application to a possible bedded salt pilot plant in Kansas; however, this work needs to be reviewed and reconsidered in terms of its appropriateness and in terms of its general applicability.

The International Atomic Energy Agency (IAEA) has also considered site selection factors for geologic disposal of solidified waste and prepared a draft report on the subject. This effort was initiated because of the world-wide interest and effort now under way to develop deep geologic disposal facilities in many countries around the world.

Basic to the concept of all of these selection factor studies is the fundamental criteria that no radionuclides from the waste will reach the biosphere in quantities that are hazardous. Of greatest concern in this regard is the transport from deep disposal by groundwater which might come in contact with the waste; as a result, many of the selection factors relate to this subject.

A few typical preliminary factors now being used as a guide in the NWTS program are the following:

Abbreviations of Typical Site Selection Factors

Depth: The site should be deep enough to avoid exposure resulting from future natural surface activities.

Configuration: The formation must be of sufficient thickness and extent to absorb the effects of the repository without reduction of containment characteristics.

Inclination: The inclination of the strata (where applicable) should be less than a few degrees for ease in mining and because it indicates a structure with less potential water flow problems.

Faults and Joints: No faults or joints should occur at the location of the site because they could lead to pathways for water flow.

Groundwater: The site should be located in an area of limited water flow.

Stability: The site should be in an area of tectonic stability and low seismicity.

FORMATIONS

At the present time, there are a number of formations which are being considered in the NWTs program. Many of these are shown in Figs. 14, 15, and 16. Figure 14 shows the rock salt formations in the USA. Of these, the Salina salt formation, the interior province of the Gulf Coast dome region, and the Permian Basin are all considered to be formations of high potential for location of terminal storage facilities. The crosshatched section in the southwest corner of the Permian Basin which is designated as the Delaware Sub-Basin is where the WIPP facility is being developed. Figure 15 shows the shale and clay formations in the USA, and Fig. 16 shows the crystalline rock formations in the USA.

STATUS OF PROGRAM

At the present, the NWTs program is in its earliest stages. The OWI has been building staff, preparing a plan, and seeking the participation of a large number of organizations around the country. The rate of expansion of the program can best be illustrated by the expansion of the budget: in FY 1976 and the transition quarter, the total budget was \$5.1 million dollars and in FY 1977 it will be \$38.2 million, or a sevenfold increase. Approximately 85% of these funds will be spent outside the Oak Ridge area with various support organizations.

The major effort and expenditure of money in FY 1977 will be for geologic studies as a continuation of past efforts including reconnaissance surveys and fieldwork in geologic study areas.

SOUTH DAKOTA STUDY

Approximately eighteen months ago, a reconnaissance survey of the Pierre Shale was started to gather existing geologic data about this formation as part of the national geologic disposal program. The formation is actually very extensive and underlies a portion of South Dakota as well as ten other states, as can be seen in Fig. 15. The study was undertaken by the special geologic projects organization of the United States Geologic Survey (USGS) under the direction of Dr. W. S. Twenhofel. Mr. George Shurr, who is part-time with the USGS, was in charge of the study. Mr. Shurr is also a staff member of the Earth Sciences Department of Saint Cloud University, Saint Cloud, Minnesota.

The purpose of the reconnaissance survey was to develop a regional mapping of the Pierre Shale across several states to describe its stratigraphy, structure, thickness, and depth. The principal source of information for the study was existing well logs which are part of the Petroleum Corporation Data Base. In addition to this, visual surveys were also conducted.

At the time the reconnaissance study started in South Dakota, Mr. Shurr contacted the South Dakota Geologic Survey to tell them about the study. Later, the state survey participated in visual surveys with Mr. Shurr.

The report on the work that has been completed is in preparation and will be available in the next few weeks. The next step in the reconnaissance study is to look at the available well log data in more detail in limited regions. One region to be covered in this phase is a vast area of over 12,000 square miles in the western part of South Dakota. Similar

areas have also been defined in other states as part of the general study. The reason this phased approach is taken is because of the large amount of log data available and the necessity to break it down into convenient packages.

It is not possible to determine at this time if the studies in South Dakota will proceed to the level of defining a study area for geologic fieldwork as defined in the development sequence. This will have to await the results of the next phase of the reconnaissance study and the review of the available information at that time.

ECONOMIC INCENTIVES

One of the initial economic benefits of the repository is that a portion of the \$300 to \$400 million that will be expended in the full construction of the facility will flow into the local area. This is not a short-term situation since it will take approximately four years for the initial construction of the repository, five years to expand the handling facilities, and then continuous mining operations over the lifetime of the repository.

In addition, another direct benefit will be the 250 to 350 new jobs operating the repository over its lifetime.

Indirect benefits will be the number of jobs created to support the construction phase and the operation of the facility as well as providing the normal services for the operating personnel living in the area.

Although the reprocessing industry is being developed by private enterprise, there is good reason to believe there will be economic advantages to them of having the fuel reprocessing plant located reasonably

close to the Federal Repository. This might mean that it would be placed in the local area or nearby in the state. One of these complete reprocessing facilities including solidification and plutonium fuel fabrication would cost in the order of \$1 billion and create a large number of new jobs, as well as having a very positive economic impact.

STATES' RIGHTS

As pointed out earlier in this presentation, nuclear power is here today and is operating to produce over 8% of the current electric power requirements of this nation. With the electrical network system now employed across this country, everyone to some extent benefits from this nuclear generated electricity.

In discharging the Federal responsibility for selecting repository sites, ERDA is mindful of the equally important responsibilities of state officials. Therefore, participation of these officials is essential in decisions leading to the final selection of nuclear waste repository sites. To fulfill their joint responsibilities, Federal and State governments must agree on appropriate workable procedures for determining the acceptability of potential sites for deep geologic isolation of radioactive wastes. It is planned that the state will participate in the development of the review procedures for site selection including the development of selection criteria for waste repository sites. It is ERDA's position that the project will be terminated if the State raises issues on the project connected with these criteria, and their application, that are not resolved through mutually-accepted procedures.

NUCLEAR POWER REACTORS IN THE UNITED STATES

NUCLEAR GENERATING UNIT CAPACITY

PUERTO RICO

■ OPERABLE	KILOWATTS
58 LICENSED BY NRC TO OPERATE	40,317,400
2 OTHERS AUTHORIZED TO OPERATE (ERDA-OWNED)	940,000
▲ BEING BUILT	
74 CONSTRUCTION PERMITS	76,931,200
19 SITE WORK AUTHORIZED	20,490,000
● PLANNED	
61 REACTORS ORDERED	69,394,000
24 REACTORS NOT ORDERED*	28,900,000
238	236,972,600

*These units have not been ordered, and site information is incomplete.

There are no symbols for units planned but not sited.

Symbols do not reflect precise locations.

Ref.: TID 8200-R33, "Nuclear Reactors Being Built or Planned in the U.S. as of December 1, 1975". Updated June 30, 1976

Figure 1.

**PROJECTED DOMESTIC POWER GROWTH
(OPA - LOW 1975)**

YEAR	GWe (TOTAL)	GWe (NUCLEAR)	NUCLEAR (% OF TOTAL)
1975	492	37	8
1980	605	70	12
1985	785	160	20
1990	980	285	29
1995	1220	435	36
2000	1550	625	40

Ref.: E. J. Hanrahan, ERDA, OPA, "AIF Summary Report Fuel Cycle
Conference '76, March 21 - 24, 1976", pp 28 - 39, June 1976.

Figure 2.

OWI-76-103

INCREASED DEMAND FOR COAL

10-YEAR HISTORY OF ACTUAL PRODUCTION
COMPARED WITH EXPECTED NEED 10 YEARS IN FUTURE

Ref.: D. W. Kuhn, ERDA-DNFCP

OWI-76-104

Figure 3.

THE LIGHT WATER REACTOR NUCLEAR FUEL CYCLE

Figure 4.

ARTIST'S CONCEPT FEDERAL REPOSITORY

Figure 5.

ESTIMATED FEDERAL REPOSITORY LAND AREAS

Figure 6.

OWI-76-118

**PROJECTED ACCUMULATION OF SOLIDIFIED HIGH-LEVEL
WASTE AT FEDERAL REPOSITORY**

DELAYED 10 YEARS AFTER GENERATION

OWI-76-123

Figure 7.

**PROJECTED ACCUMULATION OF CLADDING WASTE
AT FEDERAL REPOSITORY**

**COMPACTED TO 70% OF THEORETICAL DENSITY
DELAYED 5 YEARS AFTER REPROCESSING**

OWI-76-124

Figure 8.

**PROJECTED ACCUMULATION OF INTERMEDIATE-LEVEL
TRANSURANIUM WASTE AT FEDERAL REPOSITORY**

**VOLUME REDUCED BY FACTORS OF 3 TO 10.
DELAYED 5 YEARS AFTER GENERATION.**

OWI-76-125

Figure 9.

**PROJECTED ACCUMULATION OF LOW-LEVEL TRANSURANIUM
WASTE AT FEDERAL REPOSITORY**

**VOLUME REDUCED BY FACTORS OF 3 TO 10.
DELAYED 5 YEARS AFTER OPERATION**

OWI-76-126

Figure 10.

GEOLOGIC TERMINAL STORAGE

GENERAL PLAN

Figure 11.

GEOLOGIC TERMINAL STORAGE

PILOT PLANT NO. 1 DESIGN AND CONSTRUCTION SCHEDULE

Figure 12.

Figure 13.

OWI-76-119

ROCK SALT DEPOSITS IN THE UNITED STATES
(AFTER PIERCE AND RICH, U.S.G.S. BULL. 1148)

Figure 14.

OWI-76-25

ARGILLACEOUS FORMATIONS IN UNITED STATES

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Figure 15.

CRYSTALLINE FORMATIONS IN UNITED STATES

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Figure 16.

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