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1974 Conceptual Design Description of a Bedded Salt Pilot Plant in Southeast New Mexico

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OAK RIDGE NATIONAL LABORATORY

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1974 CONCEPTUAL DESIGN DESCRIPTION OF A
BEDDED SALT PILOT PLANT IN SOUTHEAST NEW MEXICO

Prepared by Oak Ridge National Laboratory Staff,
based upon conceptual design work performed by
Kaiser Engineers, Inc., July-November 1972

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1. INTRODUCTION

1.1 Background

The policy of the United States Atomic Energy Commission is to take custody of all commercial high-level radioactive wastes and maintain control of them in perpetuity. This policy (Title 10, Code of Federal Regulations, Part 50, Appendix F) requires that the high-level wastes from nuclear fuels reprocessing plants be solidified within five years after reprocessing and then shipped to a federal repository within ten years after reprocessing.

Ultimate disposal sites and/or methods have not yet been selected and are not expected to be ready when waste deliveries begin about 1983. Therefore, the AEC plans to build an interim storage facility, called Retrievable Surface Storage Facility (RSSF), to store and isolate the waste from man and his environment until the suitability of the permanent repository is demonstrated and public acceptance has been established.

Meantime, the AEC is proceeding with the study and development of an ultimate disposal method. Bedded salt is being considered for ultimate waste disposal, and work is in progress to develop a Bedded Salt Pilot Plant to demonstrate its acceptability. The pilot plant will permit in situ verification of laboratory work on the interaction of heat and radioactivity of the waste with the salt and surroundings. This report describes one concept of such a pilot facility. The functions and design requirements are set forth in Chapter 2. Chapter 3 describes one concept of a facility design meeting those requirements. Safety, operational, maintenance and quality assurance features of the design are outlined in chapters 4 through 8; these chapters will be developed more completely as additional design work is performed. Chapter 9 presents a

proposed engineering and construction schedule and Chapter 10 is a discussion of the possible expansion of the BSPP into a full-scale bedded salt repository.

1.1.1 Projected Generation of High-Level Wastes

Recent projections¹ of installed electric power generating capacity, annual volume and numbers of canisters of waste shipped, and heat-generating characteristics of the waste as shipped are as follows:

Fiscal Year	Installed Capacity GWe (Net)	Wastes Shipped ^a					
		Volume (ft ³)		No. of Canisters		Waste Heat (kW)	
		Annual	Cum.	Annual	Cum.	Annual	Cum.
1980	114	--	--	--	--	--	--
1990	453	4,829	19,426	769	3,093	2,599	9,067
2000	1117	19,364	137,714	3,084	21,931	10,773	88,835
2010		45,943	471,062	7,316	75,014	21,926	253,192

^aAssumes wastes shipped 10 yr after discharge from the reactors. Other assumptions are set forth in Appendix 11.1.

Detailed projections of the quantities and properties of high-level wastes that may be accumulated in the U. S. by the end of this century are presented in Table 11.1 of Appendix 11.1. As generated, these wastes are complex aqueous mixtures containing radioactive isotopes of about 35 fission-product elements and 18 actinide and daughter elements. Corrosion products from fuel cladding and plant equipment, and chemical reagents that are added during reprocessing are also present.

¹ORNL-TM-3965, Projections of Radioactive Wastes to be Generated by U. S. Nuclear Economy, J. O. Blomeke, C. W. Kee, and J. P. Nichols, February 1974.

1.1.2 Disposal in Natural Salt Formations

In the Mid-1950's, the National Academy of Sciences - National Research Council recommended the investigation of natural salt formations as a potential repository for solidified high-level wastes. This recommendation was based on a number of considerations, some which are as follows:

- ° Salt deposits are free of ground water and have been so for millions of years.
- ° Most salt deposits are located in areas of tectonic stability.
- ° Salt is characterized by ready plastic deformation and self-healing.
- ° Salt deposits are abundant and widespread in the continental United States.
- ° Salt is easily mined.
- ° Salt is resistant to damage from heat and radiation.
- ° Salt has a high thermal conductivity.

1.2 Objectives

The objective of a radioactive waste repository in salt is to provide safe, dependable, permanent disposal outside man's environment of all the high-level wastes which will accumulate from reprocessing nuclear fuel discharged from civilian power reactors. A pilot plant repository may be provided in the early 1980s as a forerunner to a full-scale repository; the pilot plant will have a total design capacity of 1000 waste containers and have the following objectives:

- a. Confirm analytical and laboratory studies bearing directly on

the operational and long-term safety of the burial plan, including gas phase transport and diffusion, radiolytic gas generation, radioisotope migration in salt, heat transfer, rock mechanics, and energy storage in salt;

- b. Establish safe shipping, receiving, handling, and retrieval techniques for waste canisters shipped in shielded casks and stored in bedded salt;
- c. Demonstrate control of effluents through extensive monitoring and surveillance of the atmosphere, ground water and land areas, both on-site and off-site;
- d. Demonstrate safe operations on a small scale;
- e. Minimize capital investment consistent with the objective of safe storage of waste for a 10- to 15-year demonstration period; and
- f. Provide minimum capability for eventual expansion from pilot plant operation to a full-scale repository.

During the operation of the bedded salt pilot plant (BSPP), all radioactive wastes will be emplaced and maintained in a fully retrievable condition while information bearing on operational safety and long-term geologic containment is accrued.

1.3 Summary Description of Facility

The significant feature of the BSPP is an excavation for access into a salt bed to allow placing canisters of high-level waste in the salt in such a manner that their behavior in and effect on the salt can be observed. Included

in the BSPP facility are the accouterments needed to make the excavation, provide access into it for the waste and for operating personnel, maintain surveillance and confinement of the waste under all conceivable conditions, and readily remove the waste if this should become necessary. All waste canisters placed in the BSPP initially will be in sleeved holes in the salt to provide easier surveillance, and retrieval if necessary. After a suitable period of satisfactory operations it is planned to provide additional equipment to allow placing waste canisters directly in salt to get more data on the waste-salt interactions. This equipment will also provide capability to retrieve and remove the waste should that become necessary. Only the capability for in-sleeve placement and retrieval is included in the current BSPP concept.

1.3.1 Site

An extensive investigative program is being conducted to select a site suitable for both the BSPP and ultimate conversion into a permanent repository. In order to provide a realistic conceptual design, a typical site in southeast New Mexico was selected as a basis for the BSPP concept. This typical site was selected on the basis of preliminary site investigation work and may or may not prove to be a satisfactory site for the BSPP. However, the conceptual design based on this typical site will be adaptable to a final site. This typical site is a 1 1/2-by 2-mile area located in a relatively undeveloped area of southeast New Mexico. Generally the area is semi-arid, sparsely populated, with most of the population dependent on tourism, petroleum production or potash mining activities.

Railroads and hard surfaced highways serve the general area, but extensions of about nine or ten miles of railway and improved highway will be required to serve this typical site. Utility extensions will also probably be required, but these have not been investigated.

Geologic features of southeast New Mexico are of paramount importance to the BSPP and a possible permanent repository in bedded salt. The salt deposits in southeast New Mexico which appear suitable for waste disposal purposes are of late Permian age. The Salado formation, the main salt-bearing unit of the study area, ranges in thickness from about 1900 ft in the south of the area to about 1000 ft in the north. This formation is divided into three informal units: lower and upper salt members, generally free of sylvite and other potassium and magnesium evaporite minerals; and the McNutt potash zone. Studies to date indicate that the potash deposits underlying this typical site are of low economic value. Several stratigraphic zones within the salt appear suitable for waste disposal. The most promising seems to be near the top of the lower salt member of the Salado formation. Depth to this member from the surface is in the order of 2000 ft at the typical site. Overlying the Salado formation are the Rustler formation consisting mainly of anhydrite and rock salt, and the Dewey Lake Redbeds consisting of siltstone and sandstone.

The study area lies near a regional ground-water divide. Essentially no ground-water flow enters or crosses the area. Only water from the surface is available for recharge.

1.3.2 Facility Description

In order to carry out the mission of placing the waste canisters in the BSPP, systems for receiving shipments, transferring them to the mine, and placing them in the prepared holes in the salt will be necessary. In addition, means must be provided for taking data, supporting operating personnel, maintaining confinement, and for retrieval of the canisters. Basic elements of the facility are the waste receiving building on the surface, the waste shaft

and hoist, a mine-level waste receiving station, and a motorized transporter to move each waste canister from the mine-level receiving station out into the mine and place it in a previously prepared hole in the mine floor. To support the operation of placing the waste canisters and, subsequently, the data-gathering phase of BSPP operations, a mine operations and administration building, a warehouse (with maintenance shop), a gatehouse, water supply and sanitary waste disposal systems, electrical substation, and a filter station for the mine air exhaust will be built on the surface. In addition to the waste shaft, a multi-compartment shaft (the main shaft) will provide access for personnel and materials into the mine and serve as the mine air supply shaft, and other shafts will serve for mine air exhaust and emergency exit from the mine. A schematic drawing of the pilot plant is shown in Fig. 1.1.

All mine space expected to be used during the BSPP life will be excavated during construction, prior to beginning operations. In the event the BSPP does become a full-scale radioactive waste repository, excavation for this purpose will then be started and facilities for salt mining, hoisting and disposal will be provided.

A brief description of the facilities for the BSPP concept follows:

- o Waste Receiving Building.--Included in the waste receiving building will be the cask unloading area, rail car air lock, transfer cell, transfer gallery, shaft sheave house, operating areas, and support facilities. The support facilities consist of a chemistry laboratory, counting and change rooms, a personnel check station, an office, maintenance and storage area, central mechanical and electrical equipment rooms for the pilot plant, and space for processing contaminated waste generated on-site. Required building services will include heating, ventilating, and air conditioning, domestic water, fire protection systems, fuel gas and oil, plant and

BEDDED SALT PILOT PLANT

Fig. 1.1

instrument air, drain and waste collection, instrumentation, and electrical services. Equipment will include an overhead bridge crane and a lift table to lift casks weighing up to 110 tons; cask and shaft access port covers; transfer cell crane, hoists, viewing windows, and manipulators; waste shaft cage; rail car puller; and miscellaneous equipment items. An exhaust fan-filter house serving the waste receiving building will be an attached below-grade structure, and the waste shaft hoist house will be nearby. The top of the waste shaft will be an integral part of the waste receiving building.

- ° Support Facilities at the Surface.--Surface support facilities will include a mine operations and administration building; a head frame, hoist, and staging building for the main shaft; a warehouse and a maintenance shop; a mine air supply fan house; and a gatehouse. The mine operations and administration building will house change and shower facilities for mine personnel, a personnel check station, dispensary, and offices for all administrative functions. A head frame and hoist house will be constructed for the main shaft, with a staging area and building adjacent to it for materials and men entering the mine. The mine air supply fan house will contain a fan and coils for heating and cooling the air supply to the mine.
- ° Mine Facilities.--In addition to the waste shaft, other facilities connected with the mine are the main shaft, the mine exhaust shaft and central filter station, a mine escape shaft, the excavated mine, and a mine-level receiving station. The main shaft will have compartments for a man and materials hoist, mine air supply, utilities

and a manway ladder. The mine exhaust shaft will accommodate all air coming from the mine. At the top of this shaft will be the central filter station to house the mine exhaust fans, filters, dampers and monitoring devices. A separate escape shaft from the mine will be provided. Rooms will be excavated in the bedded salt for the pilot plant, along with the necessary corridors connecting them with the shafts and underground support areas. The number of rooms (approximately 50, based on an average heat generation rate per canister of 3 kW) will be adequate to accommodate up to 1000 waste canisters, as well as excess salt deriving from drilling for waste canister sleeve installation and mine cleanup operations during the life of the BSPP. The mine-level receiving station will be located at the bottom of the waste shaft. This will be a shielded cell to allow transfer of waste canisters from the hoist cage to the shielded cask of the waste transporter.

For details of construction materials and building areas, see Section 3.3.

1.3.3 BSPP Operations

Waste canisters shipped to the BSPP will be sealed cans of solidified high-level waste, up to 14 in. in diameter and 10 ft long. Shipments will be in heavy shielded casks, up to 110 tons in weight. At the BSPP, a cask will be unloaded from a rail car in the waste receiving building, examined for cleanliness and integrity, and the cask and its contents will be cooled. The cask will then be moved and sealed to a transfer cell, where canisters will be removed individually by remote handling techniques, and placed in

the waste shaft hoist cage. After a canister has been lowered to the mine-level receiving station, it will be hoisted into a shielded cask on the waste transporter, again using remote handling techniques. An operator will drive the waste transporter to the storage room where a sleeve has previously been placed in the salt floor of the mine and will bring the machine to rest with the transporter cask over the sleeved hole. All personnel will exit from the room, and remote controls will be used to lower the waste canister from the transporter cask into the sleeve and place a shield plug in the top of the sleeve. Personnel re-entry will then be permissible. If desired, the procedures can be reversed and the waste canister can be removed individually for relocation, or even for removal from the BSPP.

1.4 Environmental Impact

No significant impact on the environment resulting from either the construction or operation of the proposed pilot plant is anticipated. Minor environmental effects anticipated on the surface of or below the 3-sq-mi proposed site, as well as those beyond the site boundaries, will be analyzed and reported in a preliminary Environmental Impact Statement to be prepared prior to initiation of Title I engineering.

2. FUNCTIONS AND DESIGN REQUIREMENTS

2.1 General

2.1.1 Function

The function of a radioactive waste repository in salt is to provide safe, permanent disposal of the high-level wastes emanating from reprocessing fuel discharged from civilian nuclear power reactors. The function of the BSPP is to confirm the validity of the bedded salt disposal concept.

2.1.2 Design Requirements

The BSPP shall be designed to receive canisters filled with solidified waste, with maximum dimensions of 14 in. outside diameter by 10 ft 0 in. overall length, and to store them in previously prepared sleeved holes in the floor of a salt mine. The waste canisters shall be placed and maintained in a condition which will permit their retrieval and off-site shipment with minimum preparation. The facility shall be designed to accommodate shielded shipping casks containing the waste canisters and having a maximum diameter of 10 ft 0 in., a maximum overall height of 15 ft 0 in. and a maximum weight of 110 tons. Surface facilities and systems and the waste shaft shall be designed to accommodate canisters up to 24 in. outside diameter. Appendix 11.2 details additional criteria and design requirements for the acceptance of waste canisters and shipping casks at the BSPP.

The expected life of the BSPP is 10 to 15 years. The facility shall be designed to accommodate the receipt and storage of waste canisters in accordance with the projected shipping rates shown in Table 11.1 of Appendix 11.1 for the years 1984 through 1993. The design of the BSPP shall include provisions for future expansion into a full-scale bedded salt repository capable of accommodating the receipt of canisters measuring up to 24 in. outside diameter at rates projected through the year 2010, should it be advisable to locate such a repository at the BSPP site.

The BSPP shall be designed to facilitate future decommissioning. A decommissioning plan shall be developed during the facility design.

Siting Requirements.--The principal function of the site is to provide a bedded salt formation with geological and hydrological features such that waste products placed in the salt would remain outside man's environment as long as necessary for them to become innocuous. The BSPP shall be located at a site at which there is available a storage horizon of bedded salt meeting the following basic requirements:

- o The minimum thickness of the salt formation shall be 200 ft.
- o The minimum thickness of the salt formation above the disposal horizon shall be 150 ft.

In addition, considerations shall be given to the site selection factors set forth in the following documents:

- o AEC Manual, Appendix 6202, Part 1, "Guides for Establishing Site Selection Criteria."
- o Code of Federal Regulations, 10 CFR 100.
- o ORNL-TM-4219, "Site Selection Factors for the Bedded Salt Pilot Plant," May 1973.

Resistance to Natural Phenomena.--All facilities whose failure could result in the release of excessive (considered to be excessive if it exceeds limits in AEC Manual Appendix 0524) amounts of radioactivity shall be designed to withstand the effects of all credible natural phenomena. For purposes of the design of the BSPP, these phenomena are the design basis earthquake (DBE), the design basis tornado (DBT) and the probable maximum flood (PMF).

- o Earthquake and Wind.--All structures, systems, and equipment within the BSPP will be classified by the following category groupings. This classification is applied in order to identify plant features for purposes of public safety and operational reliability during postulated earthquake and wind conditions.

Category I: All structures, systems and equipment whose failure could cause release of excessive amounts of radioactivity; or those structures, systems and equipment that are essential for the safe shutdown of waste handling operations without endangering the public health and safety during or following a design basis earthquake (DBE) or design basis tornado (DBT), as defined in Appendix 11.3.

Category II: Those structures, systems and equipment that are required to permit continuation of waste handling operations without endangering the public health and safety during and following an operating basis earthquake (OBE) or design basis winds (DBW), as defined in Appendix 11.3.

Category III: Those structures, systems and equipment whose failure will not result in release of excessive amounts of radioactivity, or are not essential to continued waste receipt and emplacement operations.

All Category III structures shall be designed to remain functional while accommodating Zone 1 seismic loadings as prescribed by the Uniform Building Code, or forces due to design basis winds.

Design criteria to meet the requirements of Categories I and II and definitions are set forth in Appendix 11.3.

- o Flood.--The basis for design of the areas surrounding all shafts will be the probable maximum flood (PMF) as determined by the procedure set forth in Civil Engineer Bulletin No. 52-8, Revised March 1965, Office of the Chief of Engineers, Dept. of the Army.

Radiological Safety and Confinement.--The exposure of operating personnel to and the general public/radiation and particulate contamination shall be minimized by application of the following design guidelines and criteria:

- o Confinement of Radioactive Materials.--The release of radioactive materials to the environment shall be prevented by providing multiple confinement barriers and controlled air flow. The first line of confinement shall be the sealed canisters of solid waste or the piping and vessels containing potentially contaminated liquid waste effluents. The secondary line of confinement shall be the sealed shipping casks or the structures in which solid waste canisters or potentially contaminated effluents are handled outside shipping casks. All waste handling structures shall have provisions for directing air flow from areas of low contamination potential to areas of progressively higher contamination potential, for confining contamination, and for monitoring the release of airborne radioactive effluents to assure that releases are within the limits set forth in AEC Manual Appendix 0524. Additional criteria for the design of confinement systems are set forth in Section 2.5 of this report.
- o Radiation Protection.--Shielding shall be provided to protect plant personnel from all sources of radiation and to assure their radiation exposure is within the limits stated in AEC Manual

Appendix 0524. Permanent shielding shall be based on the maximum radiation source expected. Interlocks and automatic alarms shall be used to prevent personnel from entering high radiation areas and to warn them of high radiation levels. Additional criteria for the design of biological shielding are set forth in Section 2.2 of this report.

- o Contamination Control.--To the extent practicable, the facility will be operated "contamination free." The design shall accommodate this philosophy by providing (1) surfaces which can be easily decontaminated, (2) decontamination systems, and (3) isolation of potentially contaminated areas. Facilities shall be provided to repackage a waste canister in the event of its failure. The repackaging capability shall not be installed in-line, however.
- o Radioactive Effluents.--Radioactive liquid or gaseous effluents released from the facility shall be "as low as practicable." shall be interpreted to mean The phrase "as low as practicable"/ less than 10 percent of the standard in AEC Manual Appendix 0524 Annex A, Table II. Potentially contaminated site-generated liquid waste shall be concentrated and solidified for storage as solid waste in the BSPP. Distillates shall be decontaminated to adhere to the standard cited above for liquid effluent.
- o Control and Instrument Systems.--Systems shall be provided to monitor and control effluents, variables, and operating systems important to the safe operation of the facility during normal, abnormal, and accident conditions.

Support Facilities and Utilities.--Design of the BSPP shall make provision for administrative functions, first aid, fire protection, safety, storage, transportation, utilities and maintenance as required to make the facility self-supporting when located at a site remote from municipalities and the attendant services afforded thereby.

Quality Assurance.--A quality assurance program shall be established to provide confidence that the structures, components, systems and facilities that comprise the BSPP are designed, developed, manufactured and constructed in compliance with established engineering criteria and to establish the means of control and verification to prevent or detect and correct any deficiencies. The criteria for the development of a quality assurance plan are set forth in Section 2.10 of this report.

2.1.3 Governing Regulations and Codes

The facilities shall be designed, constructed and operated in accordance with applicable AEC manual chapters and shall meet the intent of the appropriate parts of the Code of Federal Regulations, Titles 10 and 30. The principal regulations are:

AEC Manual Appendices:

- 0524 - Standards for Radiation Protection.
- 0550 - Operational Safety Standards
- 6301 - General Design Criteria.

Code of Federal Regulations, Title 10

Part 20 - Standards for Protection Against Radiation.

Part 50 - Licensing of Production and Utilization Facilities.

Part 100 - Reactor Site Criteria.

Code of Federal Regulations, Title 30

Part 57 - Health and Safety Standards - Metal and Non-Metallic Underground Mines.

To the extent practicable, the BSPP shall use recognized national codes and standards for design, construction, testing, and operation. Many of these codes and standards are listed in AEC Manual Appendix 6301, General Design Criteria, and in Section 3.1 of this report; others shall be identified during design.

2.2 Architectural and Structural

2.2.1 Functions

The function of the architectural and structural features is to house the systems and personnel required to fulfill the basic objectives of the BSPP with a minimum capital investment.

2.2.2 Design Requirements

2.2.2.1 Resistance to Natural Phenomena.--All BSPP areas where waste canisters will be outside their shipping casks in transit to emplacement in the salt, areas where equivalent exposure to radioactive materials exists, and areas housing equipment or systems necessary to retain confinement shall be Category I classification, as defined in Subsection 2.1.2. All other areas necessary to maintain the BSPP in a condition to receive and place waste in the salt shall be Category II classification. All other areas are to be Category III. The interpretation of these requirements as they apply to the concept described in Chapter 3 is shown on Table 3.1.

2.2.2.2 Shielding Requirements.--Radiological characteristics of waste acceptable at the BSPP are defined in Appendix 11.2. Radiation shields must be provided in all structures of the BSPP where the waste is not enclosed in the shipping casks. Radiation shields, together with the degree of occupancy of the affected zones, shall be selected such that the weekly averaged dose or dose commitment to operating personnel will be no more than 40% of the radiation protection standards prorated for one week of exposure. For continuously occupied zones, these limits are considered to correspond to a penetrating radiation dose rate no greater than 1.0 mrem/hr. Massive concrete shields for normally

occupied work areas such as the operating gallery of the transfer cell shall be designed to limit the basic dose rate to 0.25 mrem/hr to provide contingency for shield penetrations and dose accumulation in zones of high radiation.

2.2.2.3 Floor and Roof Loadings.--Floor loadings shall be as specified in American Standard Building Code, Requirements for Minimum Design Loads in Buildings and Other Structures, ANSI A-58.1, or as dictated by process and operating equipment. Live roof loads shall be 30 lb/ft² snow loading with no reduction for area.

2.2.2.4 Waste Receiving Building

Functions.--The waste receiving building is to house the system for receiving shipments of waste canisters and transferring them to the mine, and auxiliary systems and equipment needed for support of this activity.

Design Requirements.--The waste receiving building shall have an air lock of sufficient size to accommodate a shipping cask rail car; cask unloading and handling areas sized to permit unloading of the shipping casks from rail cars and cooling the cask internals; a transfer gallery for placing casks in a position to seal to the transfer cell; a shielded transfer cell for remotely unloading individual waste canisters from shipping casks and transferring them to the mine shaft; a cell operating gallery with space to perform remote in-cell operations and permit removal of manipulators for maintenance; space for process equipment, including cask cooling and liquid waste collection, concentration, and solidification; and supporting areas.

Areas containing operations in which the integrity of the shipping cask is breached, such as attaching cooling or decontamination lines to the interior of the cask and transferring waste canisters from the cask, shall be confinement areas (Sect. 2.5). Other areas which are to be designed for radioactive confinement are the transfer cell operating gallery, the waste hoist sheave house, the process equipment areas, and mechanical equipment rooms. Confinement areas shall be separated from the outside atmosphere and nonconfined areas by air locks.

Minimum space shall be provided for:

- o Material storage and equipment maintenance as required for efficient functioning of the building;
- o Building mechanical equipment;
- o Electrical switchgear and standby generators for the BSPP;
- o A chemical laboratory of $\sim 300 \text{ ft}^2$, located for convenient access to the counting room, and providing facilities for routine activity analyses on cask cooling samples, liquid waste effluents, repurified water, and routine chemical analyses on brine samples and decontamination and coolant solutions as required;
- o An office of $\sim 150 \text{ ft}^2$ to serve as an operations supervisor's office;
- o A personnel monitoring station of $\sim 150 \text{ ft}^2$, located for easy access to the cask unloading areas;
- o A counting room located adjacent to the confinement structure in an area of minimum contamination potential and low radiation

- background. Approximately 300 ft² of counting room space is required. There shall be no direct personnel access into the counting room from the confinement area, but a pass-through window shall be provided for transfer of counting samples. No shielding is required in the counting room;
- o Change room facilities located in the nonrestricted area which will serve as a buffer zone or air lock for the normal flow of personnel traffic between the confinement and nonrestricted areas;
 - o An exhaust fan-filter house to contain the exhaust fans and filters for the waste receiving building confinement systems.

Areas where the 110-ton shipping casks are handled shall be designed for the resulting high static floor loading, and to withstand the impact of a cask dropped from the highest elevation obtainable with the crane. Normal floor loadings apply to other areas.

Surface treatment allowing easy decontamination shall be provided for all contaminable surfaces of the cask unloading and cooling areas, the transfer gallery, the transfer cell, sheave house, operating gallery, and waste concentration and casting rooms.

2.2.2.5 Waste Shaft and Hoist House

Function.--The waste shaft is to provide access for transporting waste canisters between the receiving building and the mine. The hoist house will house the waste hoist and a hoist control station.

Design Requirements.--A shaft shall be provided through which waste canisters can be transferred to the mine from the surface facilities

in the waste receiving building. The shaft diameter shall be selected to accommodate ultimately a 24-in.-OD waste canister 10 ft long, repackaged in an oversized can, and a protective cage.

The interior surface of the shaft shall be free of cracks and pits and shall be amenable to decontamination by brushing or other abrasive techniques. The design must include provisions to prevent ground water from entering the mine. The location of the shaft shall be in accordance with the mine master plan. Guides shall be installed to prevent rotation of the hoist cage as it is lowered and raised.

The waste shaft hoist house must be located in proper geometric relation to the hoist sheave house, which is a part of the transfer cell structure of the waste receiving building. It shall be a confinement area and the walls shall be given a surface treatment for easy decontamination. The hoist cables spanning between the hoist house and the sheave house must be enclosed for confinement.

2.2.2.6 Mine-Level Receiving Station

Functions.--The mine-level receiving station is to provide a shielded enclosure for transferring waste canisters from the waste shaft cage into the transporter.

Design Requirements.--The mine-level receiving station shall provide a shaft station cell similar to the transfer cell above, which has shielding walls, a viewing window, and ports for manipulators and services. The hoist cage guide system will terminate in this cell, and an access port must be provided for moving waste canisters into the transporter. A gallery shall be provided adjacent to the shaft station where the operation of transferring the canisters will

be controlled. Two means of access shall be provided from the mine into the gallery. Entry into the shaft station shall be provided through an air lock. The shaft station and gallery shall be considered confinement areas with respect to the mine. Interior surfaces of both rooms shall be surface-treated to aid in decontamination.

2.2.2.7 Main Shaft, Hoist House, and Staging Building

Functions.--The functions of the main shaft are to provide access into the mine for all men and materials other than waste canisters, a duct for mine ventilating air, and space for mine utilities and a manway ladder. It will also provide a path for removing salt from the mine during construction.

Design Requirements.--To fulfill all its functions the main shaft shall have partitions forming isolated compartments for the hoist and counterweight, the air supply, the utility chase, and the ladder. For loading excavated salt during construction, the tail of the shaft shall be extended below the mine floor enough to allow loading a salt skip. A head-frame shall be built over the shaft capable of supporting the maximum hoist loads. Design of the head-frame shall include provisions to dump a salt skip and to allow space for loading and lowering awkwardly shaped pieces into the mine. Hoisting machinery and controls shall be enclosed in a suitably located structure. An air lock shall be provided at mine level to isolate the main shaft from the mine.

At ground level adjacent to the shaft a staging building shall be provided for maneuvering men and materials in and out of the hoist cage. This building shall provide a covered area for materials handling and space for storing and maintaining miners' lamps.

2.2.2.8 Mine Exhaust Shaft and Central Filter Station

Function.--The function of the mine exhaust shaft is to conduct all mine exhaust air to the surface, and the central filter station is to house the exhaust filters and fans for the air discharged from the mine.

Design Requirements.--The mine exhaust shaft and central filter station shall be economically sized to serve as the exhaust path ^{mine} for the BSPP/. Consideration shall be given to their continued use if the BSPP becomes a full-scale repository. The filter station shall provide space for installation and maintenance of the fans and filters. The arrangement shall be designed to facilitate filter monitoring, testing and maintenance and shall provide separation of the filter banks for fire protection. Structural features of the shaft and filter station shall provide the high quality of construction needed for radiological confinement and to preclude inleakage of ground water. The interior surface of the shaft shall be free of cracks and pits and shall be amenable to decontamination by brushing or other abrasive techniques. Walls of the filter station shall be treated to aid in decontamination.

2.2.2.9 Mine Escape Shaft

Functions.--The mine escape shaft is to provide a second exit from the mine in compliance with mine regulations.

Design Requirements.--The escape shaft shall be designed to comply with regulations pertaining to the operation of the BSPP. An air lock shall be provided at the base of the shaft to separate it from the mine.

2.2.2.10 Mine Operations and Administration Building

Functions.--The function of the mine operations and administration building is to house change and shower facilities for mine personnel, a personnel check station, a dispensary, and offices for all BSPP administrative functions.

Design Requirements.--There are no unusual architectural and structural requirements for the mine operations and administration building. It shall be minimum in size to accommodate the projected BSPP staff and shall be of economical construction.

2.2.2.11 Warehouse

Functions.--The function of the warehouse is to provide storage space and a maintenance shop.

Design Requirements.--The warehouse shall have open floor areas for storage of spare parts and maintenance working space and shall be of minimum cost construction.

2.2.2.12 Gatehouse

Function.--The gatehouse shall be the main information and check point for employees, visitors, and automotive traffic entering and leaving the BSPP and for controlling access to the facility. It shall also house a control and alarm system for safeguarding the facility.

Design Requirements.--The gatehouse shall be sized no larger than necessary to fulfill its function and shall be of economical construction. The control and alarm system is specified in Section 2.8.

2.3 Mine Plan

2.3.1 Functions

The function of the mine is to provide access for placing canisters of waste in the salt and allow surveillance of the waste and its effect on the salt.

2.3.2 Design Requirements

The mine plan for the BSPP is to be arranged to fit into the future overall development plan of a full-scale operating repository. This operating repository plan shall be based on receiving waste canisters as shown in Table 11.1 of Appendix 11.1. The mine development for the BSPP, however, shall be designed to accommodate only those 1000 canisters intended for retrievable storage during the BSPP operating life, at a maximum rate of 100 canisters per week. The BSPP mine development plan shall be based on the following requirements.

- a. All mining that is anticipated to be required during the life of the pilot plant and the disposal of the salt therefrom will be accomplished before operation of the BSPP starts;
- b. The storage area shall consist of 50 rooms, each 300 ft long, with 60 ft wide salt pillars between rooms;
- c. Mine panel entries, main entries, and storage rooms shall have widths and heights as required to accommodate all functioning equipment required for canister emplacement, retrieval, and maintenance. Allowance shall be made in the initial excavation to provide for estimated convergence of walls and roofs during the lifetime of the BSPP;

- d. All waste canisters shall be stored in sleeved holes;
- e. The initial capital outlay for excavation shall be minimized, consistent with other considerations;
- f. The BSPP shall be arranged so that it will be included in an initial storage area ~2000 ft square, if and when the BSPP is converted to a full-scale repository;
- g. The full-scale repository storage area shall be arranged so that disposal operations will generally retreat from the periphery of the mine back toward the shaft area;
- h. Air flow patterns in the mine shall be designed to move successively through entries, storage rooms, and out through noninhabited exhaust tunnels;
- i. The effects the arrangement of the mine shafts will have upon future expansion of the mine to a full-scale repository shall be taken into consideration;
- j. No BSPP rooms will be backfilled with salt;
- k. The small quantities of salt remaining to be excavated during waste storage operations (drilling of holes to accommodate waste canister sleeves and cleanup salt) shall be stored in vacant spaces provided within the BSPP mine;
- l. Depth of the mine below the earth's surface shall be assumed to be 2000 ft;
- m. Distances between waste storage areas and adjacent areas in which current or future operations will be conducted shall be adequate to ensure that temperatures in these adjacent areas will not exceed that specified in Section 2.5.

- n. The overall mine arrangement shall include appropriate areas for support functions such as underground maintenance, first aid, material storage, personnel assembly, and underground electrical equipment. These shall be sized for BSPP operation, with due consideration given to future expansion requirements for a full-scale repository.

2.4 Waste Handling System

2.4.1 Function

The function of the waste handling system is to receive canisters of solidified high-level wastes from commercial spent fuel reprocessing plants and to emplace these wastes in the underground salt bed in such a manner that they will be easily retrievable.

2.4.2 Design Requirements

Shipments of canned, solidified, high-level waste will be received at the waste receiving building in shipping casks on rail cars. The shipments will conform with regulations of the Department of Transportation and the Atomic Energy Commission. The conditions under which these casks and the waste canisters contained therein are acceptable are described below. The handling system shall have the following capabilities:

- Monitor external surface of cask for contamination;
- Clean externals of shipping vehicle and cask as necessary;
- Unload shipping casks weighing up to 110 tons from the rail cars;
- Monitor the internal atmosphere of the casks for airborne activity;
- Cool the cask internals and waste canisters;
- Remotely unload the waste canisters from the shipping casks;
- Visually inspect each waste canister;
- Decontaminate and/or repackage as necessary;
- Transfer the waste canisters to the mine;
- Remotely transfer the waste canisters into a shielded transporter;
- Transport the waste canisters to storage rooms;

- Remotely deposit the waste canisters into previously prepared sleeved holes in the salt floor;
- Position shielding plugs in the top of the sleeves; and
- Retrieve the waste canisters from the sleeves and remove them from the facility.

In addition to the above, the following requirements are imposed to facilitate safe receipt, unloading, handling and emplacement of waste canisters at the BSPP:

- The capacity of the waste handling system shall be at least 100 canisters per week.
- The high-level waste shall be assumed to be received in rail cars that have maximum length over the couplings of 66 ft.
- The shipping cask shall have outside diameter no greater than 10 ft and overall length no greater than 15 ft.
- The loaded cask and associated lifting appurtenances shall weigh no more than 110 tons.
- The cask contents shall have thermal power no greater than 45 kW.
- The internal atmosphere of the cask shall be an inert gas.
- The cask shall be provided with connections, approved by the AEC, that are suitable for venting internal pressure, sampling the internal atmosphere, and cooling the waste canisters prior to opening the cask.
- The cask shall be provided with a shield plug and a top sealing surface of a design that is compatible with unloading from the top into a shielded transfer cell.
- The design of the system shall not preclude future truck shipments.
- The transfer cell, waste shaft, and mine-level receiving station shall be designed to accommodate waste canisters with a maximum o.d. of 24 in.

The mine-level handling system shall be designed for a maximum canister o.d. of 14 in. All facilities shall be designed for a canister varying from 2 ft to 10 ft in overall length and weighing up to 8000 lb.

- o The waste heat generation per canister shall not exceed 5000 watts upon receipt at the BSPP, and the outer surface of the canister shall not be contaminated with transferable isotopes in excess of 300 dis/min/dm² of alpha radiation and 10,000 dis/min/dm² of beta-gamma radiation.
- o The waste canister shall be equipped with a standard connector pin for lifting and handling.

Additional requirements relating to waste composition and properties, nuclear criticality, waste canister integrity, and mechanical interfaces between the shipping cask and the BSPP are covered in Appendix 11.2.

2.5 Heating, Ventilating, Air Conditioning and Confinement

2.5.1 Function

The functions of the heating, ventilating, and air-conditioning (HVAC) and confinement systems are to provide protection for equipment and satisfactory working conditions for operating personnel, and to restrict discharge of radioactive contamination to such levels that no harm will come to the public or the environment. (Ref. subsection 2.1.2.)

2.5.2 Design Requirements

The HVAC systems shall combine with the building structures to form confinement systems which will prevent radioactive materials from being spread through the facility and control their discharge from the facility. To accomplish this all areas of the facility shall be divided into primary confinement, secondary confinement, and unconfined areas which are defined as follows:

- o Primary confinement areas are those areas subject to the greatest potential of airborne or surface contamination, comprising the areas where waste canisters are exposed outside the shipping casks, areas where waste generated on-site is concentrated and solidified, and mine areas in the ventilation path downstream of waste storage.
- o Secondary confinement areas are those surrounding or adjacent to primary confinement areas.
- o Unconfined areas are those where there is no potential for radioactive contamination.

Design conditions shall be based on data published in the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook of

Fundamentals. Summer outside design temperatures shall be 101°F dry bulb (DB) and 72°F wet bulb (WB). Winter outside design temperature shall be 10°F. Inside design conditions for surface buildings shall be 76°F DB with no humidity control for all air-conditioned spaces. Inside design conditions for spaces not air-conditioned shall be 65°F in winter and without humidity control and not more than 105°F in summer. Design conditions for occupied mine spaces shall be 65°F in winter and 85°F in summer.

The following requirements shall apply to the confinement ventilation systems:

- o Under conditions in which radioactive contamination has been released within confinement areas, these areas shall be maintained at a negative pressure relative to the atmosphere. For increased reliability and simplicity, systems shall be designed to operate normally in this condition.
- o Two barriers shall be maintained between the radioactive waste and the environment at all times.
- o All entries to confinement areas shall be made through air locks to preclude loss of confinement and the possible escape of contaminants to the atmosphere.
- o Air in the structures shall flow from areas of least contamination potential to areas of increasing contamination potential.
- o Recirculation of air within zones of similar contamination potential, or from zones of lesser to greater contamination potential is permitted, if passed through high efficiency particulate (HEPA) filters.
- o Confinement ventilation systems shall be backed up by standby systems to maintain confinement in the event of fan breakdown, filter failure, or normal power outage.

- o Normally inhabited areas of confinement zones shall be ventilated with six to ten air changes per hour, depending upon the usage of the zone.
- o Fresh air makeup air to all confinement zones shall flow through prefilters (30% NBS), main filters (90% NBS) and HEPA filters before being distributed to these zones.
- o Exhaust and inlet air paths to all confinement spaces shall be equipped with a backflow preventer device that blocks and seals the air path when the differential pressure caused by resistance in the normal direction is zero.
- o Corrodents or moisture in the exhaust air capable of damaging the filters shall be removed or neutralized prior to discharge to the filters.
- o HEPA filter systems shall be designed to be tested in place at a prescribed frequency (normally twice a year), using dioctyl phthalate (DOP) aerosol, and shall have a minimum test efficiency of 99.95%.
- o Confinement systems shall be designed to maintain their integrity in the event of fire.
- o Primary and secondary confinement exhaust systems shall be separate, with the secondary system being capable of maintaining confinement if the primary is breached.
- o Primary confinement system exhaust streams shall pass through two stages of separately testable HEPA filters before release to the atmosphere. Secondary confinement exhaust streams shall pass through at least one stage of testable HEPA filters.
- o Confinement systems shall be designed for periodic testing, and such tests will be a regular part of the pilot plant operating procedures.

o Primary confinement systems shall be designed as Category I structures (ref. sect. 2.1) and secondary systems as Category II.

o Continuous stack monitoring and alarm systems shall be provided to detect high activity levels in exhaust air (Ref. Sec. 2.8).

Table 2.1 lists areas of the pilot plant and the levels of HVAC and confinement treatment that shall be given to each.

Table 2.1

Areas	System Requirements				
	Heating - Ventilating Only	Heating, Ventilating and Air Conditioning	Primary Confinement	Secondary Confinement	Non- Confined
<u>Receiving Building Areas:</u>					
Transfer Cell		x	x		
Operating Gallery		x		x	
Cask Unloading Area		x		x	
Transfer Gallery		x		x	
Cage Loading Compartment	x		x		
Waste Shaft	x		x		
Waste Concentration Room		x	x		
Waste Casting Room		x	x		
Mechanical Equipment Room	x			x	
Exhaust Fan-Filter House	x			x	
Waste Shaft Hoist House		x		x	
Chemistry Laboratory		x			x
Personnel Check Station		x			x
Counting Room		x			x
Office		x			x
Change Room		x			x
Maintenance and Storage Room	x				x
Electrical Equipment Room	x				x
Diesel Generator Room	x				x
Central Control and Monitor Room		x			x
Decontamination Equipment Room	x			x	
Tank Pit	x			x	

Table 2.1 (Cont'd)

Areas	System Requirements				
	Heating - Ventilating Only	Heating, Ventilating and Air- Conditioning	Primary Confinement	Secondary Confinement	Non- Confined
Mine Operations and Administration Building (all areas)		x			x
Warehouse	x				x
Staging Building	x				x
Main Shaft	x				x
Man and Materials Hoist House:					
Machine Room	x				x
Control Room		x			x
Gatehouse		x			x
<u>Mine Areas:</u>					
Receiving Station Cell		x	x		
Receiving Station Operating Gallery		x		x	
Waste Storage Rooms	x		x		
Waste Storage Entry	x			x	
Mine Support Areas	x			x	
Exhaust Tunnels	x		x		
Central Filter Station and Mine Exhaust Shaft	x		x		
Mine Escape Shaft and Air Lock	x				x

2.6 Electrical System

2.6.1 Functions

The electrical system is to supply all the electric power needs of the pilot plant with the degree of reliability required for the end function of each power requirement.

2.6.2 Design Requirements

2.6.2.1 Power.--Electrical power needs of the pilot plant fall in the three following groups:

Normal Power: Served from the normal utility power source with no backup service provided at the pilot plant.

Standby Power: Served from the normal utility power source but also provided from one or more standby generators (diesel-driven) having an on-site fuel supply; automatic switch-over and starting system shall be provided.

Uninterrupted Power: A power supply which shall not be interrupted even for the period of time required to start a standby generator.

Specific power requirements for the pilot plant are:

- o Normal power shall be supplied by the local utility;
- o All electrical wiring between the substation and the facility, and between facility surface buildings, shall be in underground ducts;
- o Underground duct banks shall consist of rigid conduit encased in red-colored concrete, with manholes provided to facilitate cable installation;
- o The reliability of the standby power system shall be adequate to insure that standby power will be available within 30 minutes of loss of normal power;

- o On-site standby power generation equipment shall match the primary distribution voltage of the normal power;
- o Standby power feeders shall be run underground in separate conduits from normal power;
- o All loads on the standby distribution system must restart automatically following loss of normal power and upon availability of standby power;
- o When normal power again becomes available after a power outage, the resumption of the normal mode of operation must require a deliberate action on the part of the operator to switch standby bus back to normal power;
- o Requirements for standby power include: equipment necessary to maintain confinement of ventilation and potentially contaminated liquid systems, radiation monitoring instruments, communication systems, and the man and materials hoist;
- o Uninterrupted power requirements include exit lighting, emergency communications, and control and monitoring instrumentation;
- o The standby and uninterrupted power systems shall be Category I (sect. 2.1).

2.6.2.2 Lighting.--General lighting shall be provided in each room, shop and area of the pilot plant. Lighting levels within the buildings shall be as recommended by the IES Handbook. Supplemental lighting shall be provided in areas where high lighting intensity is required.

Exterior lighting shall be provided for the parking lot, at the entrance gate, at building entrances, along walkways, at the main substation, and at the central filter station. Obstruction lighting shall be provided, if required, for the pilot plant surface structures in

accordance with Federal Aviation Regulations.

Lighting shall be provided in the pilot plant mine. Illumination levels at the man and materials station, support areas, and the mine-level receiving station shall be designed for the requirements of operations in these areas. Levels in entries and storage rooms shall be minimal with portable lamps used when needed.

Emergency lighting operating from the uninterrupted power source shall provide sufficient light for personnel to move safely in all surface buildings. In the man and materials station and support areas, illumination during power outage shall be provided by portable, continuously charged dc lights. All personnel in the mine will be required to wear miners' lamps.

2.6.2.3 Communications.--Normal oral communications between various areas of the pilot plant, both surface and mine-level facilities, shall be over commercial telephone lines. Adequate conduit shall be included for installation of these lines.

2.7 Site Improvements, Utilities and Services

2.7.1 Functions

The functions of the site improvements are to provide walks, roads and parking areas, fencing, and grading and landscaping required to accommodate structures and control rain water runoff. The functions of the utilities and services are to provide railroad service; a supply of water, fuel, and compressed air; sanitary waste disposal; and treatment of any radioactive liquid waste generated at the pilot plant.

2.7.2 Design Requirements

2.7.2.1 Site Improvements

Site Clearing, Grading, and Landscaping.--Only that grading necessary to provide roads, parking areas, drainage ditches and adequate surface drainage control shall be done. Storm sewers with free outlets to receiving water courses shall be provided to convey water collected by catch basins, roof drains, and subsurface drainage systems. For estimating rainfall the 10-year rainfall curve, published by the U. S. Weather Bureau, and a time period of 60 minutes shall be used except for areas surrounding the shafts. For these, the "probable maximum flood" shall be used (Subsection 2.1.2).

Grading plans shall minimize the area disturbed by construction activities and shall provide for restoration of all disturbed areas. All newly graded areas shall have native ground cover applied.

Roads and Parking.--A two-lane access road shall connect the site to the nearest existing road having adequate capacity for traffic to the BSPP. Two-lane roads shall be provided to the mine operations

and administration building, the main shaft, the warehouse, and the waste receiving building. A single lane road shall be provided to the mine exhaust shaft. Parking areas, large enough for the initial personnel complement and arranged for future expansion, shall be provided. Parking shall be provided outside the exclusion fence for private vehicles and inside the exclusion fence for plant vehicles. All roads and other paved areas shall be designed for their intended service conditions.

Fencing: Exclusion fencing shall be provided around the portion of the site surrounding all BSPP surface structures to maintain access and operational control within the pilot plant. The fence shall be a 7-ft-high chain link fence topped with three strands of barbed wire on brackets, angled outward, 1 ft high, for a total height of 8 ft. Fencing design shall be in accordance with the requirements of AEC Manual Appendix 2401, Part II, C.3.a.

2.7.2.2 Utilities

Railroad.--A standard gage railroad extension to the BSPP site will be required, with sidings on the site to accommodate loaded and five unloaded rail cars, each having an five/overall length of 66 ft. The track layout shall provide for future extension for both loaded and empty cars. A means for moving rail cars on the site shall be provided without depending on commercial rail switching service.

The railroad installation shall conform to AEC General Design Criteria Appendix 6301, the AREA standards, and the standards of the local operating railroad for the proposed rail car loads.

Water.--An adequate supply of water shall be provided for the pilot plant to satisfy requirements for domestic water,

process needs, and fire protection. A common supply is adequate for all purposes, with an elevated storage tank providing distribution pressure and a reserve capacity equal to two hours demand for fire fighting purposes. A looped distribution system shall serve the developed area, with fire hydrants at intervals on the loop and laterals to serve the buildings with domestic and fire protection water.

Fuel.--It shall be assumed that natural gas will be available as the primary fuel source for heating. Gas distribution to the buildings shall be at approximately 15 psig with reduction to 0.25 psig at the service point to each building. Fuel oil storage on-site shall be provided to serve as backup fuel.

Sanitary Waste.--A sanitary waste system shall be provided to collect and dispose of all the sanitary waste generated at the above-ground portion of the pilot plant facilities. Treatment of the sanitary wastes shall be done on-site with a packaged, factory-assembled sewage treatment plant, providing the equivalent of primary and secondary treatment giving a 90% reduction in 5-day B.O.D. Sanitary wastes that are generated in the mine shall be collected in self-contained chemical toilets which will be serviced by a contractor for disposal off site, or the contents shall be disposed of in the on-site treatment plant. Wastes from potentially contaminated sources shall not be discharged to the sanitary waste system.

2.7.2.3 Services

- a. Waste Receiving Building.--Piped services shall be supplied in the waste receiving building for domestic, process and fire protection water, fuel gas and backup fuel oil, compressed air for instruments and general service, and drain and waste collection systems.

In addition to these general services, there shall be provided a system for cooling shipping casks and the waste canisters in them, and a system for decontaminating site-generated waste.

- o General Services.--The domestic water system shall provide an adequate supply of potable water to all sanitary, utility and process use points. Sanitary requirements shall be established on a fixture unit basis in accordance with the National Plumbing Code. Supply connections shall be made to the boilers, air conditioning systems, the hood and benches in the chemistry laboratory, and other process equipment. All process connections shall be made through an air gap or an approved reduced-pressure-principle backflow preventer to preclude contamination of the potable water system.

Fire protection shall be provided by a wet pipe sprinkler system supplemented by portable fire extinguishers. Sprinkler heads in confinement areas shall be rated at 286°F and in other areas at 165°F. Water drainage from the discharge of sprinklers in confinement areas shall be collected in intercepting trenches and drained to a waste collection tank for subsequent monitoring, processing and disposal.

The fuel gas system shall provide the primary fuel for the space heating boiler. Fuel gas shall be supplied to the hood and benches in the chemistry laboratory and to the domestic water heater. No. 2 fuel oil shall provide backup for the fuel gas to the space heating boiler. A minimum of 10 days supply of fuel oil shall be stored on the site in an underground tank.

An air system shall supply compressed air at 100 psig nominal pressure to utility stations and maintenance tools, as well as dry, oil-free air at reduced pressure for instruments, controls, and operators of the process, utility, and HVAC systems. A 15-psig supply shall be provided to the hood and benches in the chemistry laboratory. At least two compressors shall be provided, with one being available under all conditions. Standby power shall be provided to operate one compressor and all its controls and accessories, and this group of equipment shall be Category I (Sect. 2.1).

Drain and waste collection systems shall collect and dispose of sanitary wastes, process wastes, and roof drainage. Roof drains shall be discharged to the surface drainage. Sanitary waste from plumbing fixtures and floor drains in areas not subject to contamination shall be drained to the BSPP sanitary waste system. The waste from change room showers, personnel check station laboratories, janitor sinks in confinement areas, the chemistry laboratory and from process and floor drains in all potentially contaminated areas (confinement areas) shall be drained to a waste collection tank for subsequent monitoring, processing and disposal.

- o Cask Cooling System.--A closed-loop recirculating liquid cooling system shall be provided to lower the temperature of the waste canisters and shipping casks prior to removing the canisters. Cooling of the cask and canisters shall be accomplished by circulating the cooling liquid through the cask neutron shield, lowering the temperature of the cask wall, and allowing the canisters to cool

by radiation to the wall. The cooling capacity of the cask cooling system shall be approximately 1,400,000 BTU per hour. Provisions shall be made to conduct circulating cooling liquid through the cask prior to moving the cask into the transfer gallery, and also while the cask is in the transfer gallery and sealed to the transfer cell for unloading.

- o Site-Generated Waste.--The function of the process waste system shall be to decontaminate any radioactive liquid waste generated in the operation of the pilot plant as far as practicable below the limits set forth in AEC Manual Chapter 0524 and to reduce the waste to forms suitable for disposal or storage within the facility.

The process waste system shall collect and routinely process all potentially contaminated solutions emanating from process-oriented functions. Non-process, potentially contaminated wastes such as change room shower and sink effluents and fire protection water discharges shall be routed to a collection tank; they will be monitored and, if contaminated, will be processed.

The solutions to be processed shall be neutralized and successively evaporated, condensed, and passed through a cation-anion column. Instrumentation and sampling points shall be provided for process control. In the event of incomplete decontamination, recycle lines shall permit solutions to be

returned for additional processing. After satisfactory decontamination, the condensate will be reused as makeup to cooling systems.

The evaporator concentrate, containing the bulk of the radioactive contaminants, shall be blended with dry cement/^{or other agents} and solidified in packages which can be stored on-site in the mine or shipped elsewhere for storage, if necessary.

- b. Waste Shaft Hoist House.--Services to the hoist house shall consist of compressed air for maintenance uses and instrument air for HVAC controls. Wet pipe sprinklers shall also be provided.
- c. Main Shaft Hoist House and Staging Building.--Compressed air for maintenance and instrumentation shall be supplied to the hoist house and staging building. A process water hose connection shall be provided at the staging building. Fuel gas and standby oil shall be supplied for heating these buildings and for heating the mine air supply. Fire protection shall be provided by a wet pipe sprinkler system.
- d. Central Filter Station.--Compressed air for maintenance and instrumentation shall be provided. The station shall have a wet pipe sprinkler system.
- e. Mine Operations and Administration Building.--The piping systems serving this building shall be domestic water, wet pipe sprinklers, sanitary waste, fuel gas and backup fuel oil. Wastes from the personnel check station sink and the shower in the change room shall be drained to the a collection tank for monitoring and subsequent disposal.
- f. Warehouse.--The warehouse shall be provided with domestic water, fire protection sprinklers, sanitary waste, plant and instrument air, and fuel gas.

g. Gatehouse.--Services shall consist of domestic water, fuel gas, instrument air, sanitary waste, and fire protection sprinklers.

2.8 Monitoring and Surveillance

2.8.1 Functions

The functions of the monitoring system shall be to monitor continuously the interior of the pilot plant and its personnel, the facility site, and the region surrounding the facility for possible releases of radioactive or noxious materials, for any instabilities in the safety and confinement systems, and for possible effects of operation of the pilot plant on the site and environs.

2.8.2 Design Requirements

2.8.2.1 Site Monitoring.--Radiation and monitoring instruments shall be provided at the pilot plant to monitor all effluents from the buildings and the mine, to monitor the BSPP site for fallout and airborne activity, to **document** release rates, and to demonstrate safe operation of the facility.

Site monitoring equipment shall include in-stack samplers, alpha and beta-gamma monitors and gas flow measurement equipment in the facility exhaust air stacks; perimeter air and fallout monitors near the site boundaries; and surface storm water drainage monitors at appropriate locations where the drainage leaves the site.

Radiation monitoring of the region outside the BSPP perimeter will include measurements of surface contamination, radiation dosage and periodic tests of ground and surface water and vegetation to provide a continuing evaluation of the effect of pilot plant operation on the area. The regional monitoring system shall not be included in the BSPP conceptual design, however, but will be included in a joint program involving AEC and state and local agencies.

2.8.2.2 Radiation Monitoring - Internal.--Radiation and contamination monitors shall be located at appropriate places within the pilot plant facilities to survey all incoming and outgoing personnel, material and equipment and to monitor all levels of airborne activity within areas of potential contamination. Radiation monitors in all areas in which there is potential hazard from penetrating radiation or airborne contamination shall be equipped with alarms. In addition, portable survey instruments shall be provided for local radiation monitoring of specific, nonroutine operations involving a potential for release of radioactive particulates or radiation exposure to personnel.

2.8.2.3 Confinement and Safety Monitoring.--All instrumentation and alarms that indicate, control, or record data relating to the integrity of the confinement systems, fire protection systems, radiation monitoring systems, utility and power systems, and process operations shall be located at a central control and alarm station in the waste receiving building. This arrangement shall permit surveillance of all important instrumentation at one single location. The most critical alarms shall also be duplicated at the gatehouse in case of off-hour emergencies when operating personnel are not on duty at the central control and alarm station.

2.9 Safety Considerations

2.9.1 Operations

2.9.1.1 Functions of Operating Systems.--The function of the operating systems of the BSPP is to maintain the safety of the operating personnel, the public and the environment during the fulfillment of the pilot plant's mission.

2.9.1.2 Design Requirements for Reliability of Operating Systems

General:--A high degree of reliability is required for some areas of pilot plant operations, requiring that secondary backup equipment be installed to carry out functions if the primary equipment fails. A reliable backup method shall be provided for any operation which, once commenced, must be completed, and for any equipment whose failure would endanger the integrity of confinement or safety systems. Such operations are those whose failure might expose operating personnel to intolerable radiation levels, endanger the public or environment, or require the pilot plant to cease operating for extended times. These operations include the following:

- o Equipment for remote handling of waste canisters inside shielded cell structures;
- o Equipment for handling waste shipping cask shield plugs in the transfer cell;
- o Ventilation fans and filters for confinement systems;
- o Process pumps for liquid waste streams in the site-generated waste concentration and solidification system;
- o Standby electrical equipment, particularly diesel generators and their support systems;

- Utility pumps for water and fuel supply systems, coolant recirculating systems, and boiler feed;
- Cell cooling equipment; and
- Instrument air supply compressors.

Remote Handling:--All equipment which must operate behind shielding enclosures to protect operating personnel from radiation shall be remotely operated. These functions include those in the transfer cell, the mine-level receiving station, the waste shaft, the waste concentration and casting rooms, and certain of the operations involved in storage and retrieval of the waste canisters in sleeved holes in the mine floor.

Typical of the kinds of remote equipment which will be used are hoists and cranes, master-slave manipulators, viewing windows, shielding enclosures, automatic conveying equipment, process pumps, and certain functions of the waste transporter.

Contamination Control:--Within the pilot plant, contamination limits and the frequency of occupation of the zoned areas shall be selected such that the weekly averaged dose or dose commitment to operating personnel will be no more than 40% of the radiation protection standards prorated for one week of exposure. For continuously occupied zones, these limits are considered to correspond to levels of transferable surface contamination no greater than 300 dis/min/dm^2 from alpha-radiation and $10,000 \text{ dis/min/dm}^2$ from beta-gamma radiation.

Posted, controlled access "Contamination Zones" shall be established in those areas which have significant potential for direct reading surface contamination in excess of 300 dis/min/dm^2 of alpha

or 10,000 dis/min/dm² of beta-gamma or for transferable surface contamination in excess of 10% of these values. Contamination control shall be accomplished through the use of physical confinement barriers and, where possible, the maintenance of a flow of air in the direction of increasing contamination potential.

"Regulated" zones with physical confinement barriers shall be provided as a buffer between contamination zones and the environment. Such zones will consist principally of air locks and change rooms for entry and egress of personnel and materials.

The principal source of off-site exposure to radiation or radioactive materials originating from the BSPP will be as the result of the routine release of small quantities of airborne radioactive materials that have passed through HEPA filters. Personnel and vehicle access to zones of any significant radiation or contamination hazard within the site shall be limited by a chain link exclusion fence that surrounds surface facilities of the pilot plant.

Confinement barriers (including critical structures and ventilation systems) and personnel protection and instrument systems shall be designed to ensure that the necessary confinement potential and radiation safety are maintained following exposure to any credible internal and external forces.

2.9.2 Maintenance

2.9.2.1 Functions of the Maintenance System.--The functions of the maintenance system are, where possible, to prevent equipment breakdown through preventive maintenance procedures, and to make repairs when necessary.

2.9.2.2 Design Requirements of the Maintenance System.--

Repairs: Repairs to equipment and structures shall be of three general types, depending upon the levels of radiation involved, the ease of access, and the probability of failure (or inversely the reliability).

- o Contact.--Equipment and facilities with little or no potential for contamination shall be designed to permit direct contact for repairs or replacement as required.
- o Semi-remote.--Equipment with significant potential for contamination or located in a high radiation field, and having a definite failure probability, shall be designed for removal and replacement using remote handling equipment such as master-slave manipulators and in-cell hoists and cranes. These techniques will be useful in such areas as the transfer cell and the mine-level receiving station, in particular.
- o Decontamination - Contact.--Structures and equipment with extremely low failure probability shall be maintained by shutting down operations and conducting decontamination procedures specially prepared for the occasion, followed by direct contact repairs. This type of repair will be used for in-cell structures, such as walls or crane rails; shaft interiors; waste hoist house, head frame, and cable enclosures; cage loading equipment; waste concentration and casting rooms; waste transporter; and filter housings.

Filter Changeout.--A system shall be designed to permit change-out of contaminated filters into bags for disposal, either by direct handling or using a portable radiation shield when required.

2.10 Quality Assurance

A quality assurance program shall be established for the BSPP project to assure that the quality required for safe, reliable, and economical operation will be achieved. Prior to the start of Title II engineering, the quality assurance program plan shall be established which shall describe policies, practices and procedures of implementation to prevent or detect and correct any deficiencies. Each facility component shall be classified according to the consequences of its failure, associated safety hazards, and the required operational capability and reliability, and the commensurate level of effort to obtain the required quality shall be assigned.

3. FACILITY DESIGN DESCRIPTION

3.1 Codes and Standards

3.1.1 Basic Regulations and Standards

Design and construction of the BSPP will conform to AEC Manual, Chapter 6301, "General Design Criteria," and Appendix thereto; ORO Supplement to the Manual (OR-6301 and OR-Appendix 6301); and applicable Federal regulations referenced in these documents. The latest edition of all codes and standards will apply. The principal Federal regulations governing design, construction, and operation of the facility are found in the Atomic Energy Act of 1954 as amended and implemented by the AEC Manual and Title 10 of the Code of Federal Regulations, while those governing operations in mines are given in Title 30. For mining features not covered by Title 30, Mine Safety Orders from California Administrative Code Title 8, Industrial Relations, will apply.

Fallout shelter space and equipment for all BSPP personnel will be provided in the mine.

All features necessary to comply with Executive Order 11507 (Air and Water Pollution) will be provided.

3.1.2 Safety Standards

3.1.2.1 Radiological Safety. - Radiation control and monitoring systems for the BSPP will be in conformance with the AEC Manual, Chapter 0524, "Standards for Radiation Protection," and applicable standards referenced therein. These standards have basically the same provisions and limits as those required for AEC licensees by 10CFR20. The policy of these standards is to "protect the general public, AEC and AEC contractor personnel, and property" and that "operations shall be conducted in such a manner as to assure that radiation exposures to individuals and population groups are limited to the lowest levels technically and economically practical."

3.1.2.2 Industrial Safety. - The standards for industrial safety will be in conformance with the AEC Manual, Chapter 0550, "Operational Safety Standards," and applicable standards referenced therein. The policy of these standards is "for the protection of AEC and AEC contractor employees, the general public, and the environment, and for minimizing damage to, or the loss of, property from the hazards resulting from AEC operations." One of the prescribed standards of Chapter 0550 is the General Design Criteria, AEC Appendix 6301, which establishes criteria to be used for the purpose of incorporating economy, safety and sound practices in the design and construction of facilities. Other standards listed in Chapter 0550 that will be particularly applicable to the design and construction of the BSPP are listed below.

General Safety

- o 41CFR50 204, Regulations pursuant to the Walsh-Healy Act (except for radiation exposure limits and reporting requirements).
- o Dept. of Labor Occupational Safety and Health Standards; National Consensus Standards and Established Federal Standards 29 CFR 1910 (Effective Aug. 27, 1971)

Construction Safety

- o Safety Code for Building Construction, ANSI A10.2 (and related standards A10.3 thru A10.11, and A10.13).
- o General Safety Requirements, EM 385-1-1. U.S. Corps of Engineers (Department of Army).

Explosives Safety

- o Safety Manual, AMCR 385-100, U. S. Army Material Command (AMC), (supersedes AMCR 385-224).
- o Blaster's Handbook, E. I. du Pont de Nemours & Company.
- o Safe Storage, Handling, and Use of Commercial Explosives at Metal Mines, Non-Metallic Mines, and Quarries, Information Circular 7674, Bureau of Mines (DOI),

Motor Vehicle and Traffic Safety

- o Manual on Uniform Traffic Control Devices for Streets and Highways, Bureau of Public Roads (DOT).
- o A Policy on Geometric Design of Rural Highways (AASHO).

Transportation and Packaging of Radioactive Material

- o Safety Standards for the Packaging of Radioactive and Fissile Materials, AEC Manual Chapter 0529.
- o Department of Transportation (DOT) Regulations 49CFR-173.389 through 173.399.
- o AEC Regulations 10CFR71, "Shipment of Radioactive Materials."

Fire Protection

- o Industrial Fire Protection, AEC Manual Chapter 0552.
- o National Fire Codes (NFPA).
- o Uniform Building Code (ICBO).

Industrial Hygiene

- o Current Threshold Limit Values (ACGIH).

Environmental Protection

- o Federal Water Pollution Control Act as amended, 33USC466h.
- o Prevention, Control, and Abatement of Air and Water Pollution, AEC Manual Chapter 0510.
- o Standards and Specifications for Water Supply, Treatment, Distribution System, and Storage Equipment, Materials and Procedures (AWWA).
- o National Plumbing Code, ANSI A40.8.
- o Air and Water Pollution Control Facilities, AEC Appendix 6301.
- o Clean Air Act

3.1.3 Design and Construction Codes and Standards

The following codes and standards, some of which are referenced in Chapters 0524, 0550, 0552 and 6301 of the AEC Manual, are applicable to the design of the BSPP. Other codes or standards referenced in these AEC Manual chapters will be followed where appropriate.

General Design Standards

- o General Design Criteria - AEC Manual Appendix 6301.
- o Uniform Building Code, International Conference of Building Officials.
- o American Standard Building Code, Requirements for Minimum Design Loads in Buildings and Other Structures, ANSI A-58.1.

Seismic Design

- o Uniform Building Code, International Conference of Building Officials (ICBO).
- o Nuclear Reactors and Earthquakes, TID 7024.

Wind Design

- o Wind Forces on Structures, ASCE Paper No. 3269

Reinforced Concrete

- o Building Code Requirements for Reinforced Concrete,
American Concrete Institute (ACI-318)

Structural Steel

- o Specification for the Design, Fabrication and Erection of
Structural Steel for Buildings, American Institute of Steel
Construction.
- o Structural Welding Code D1.1, American Welding Society (AWS).

Open Web Joists

- o The Steel Joist Institute Standard Specification for Open-Web
Steel Joist Construction.

Concrete Block Construction

- o Crack Control in Concrete Masonry Unit Construction -
Publication 1198, National Academy of Sciences - National
Research Council.
- o Building Code Requirements for Reinforced Masonry, ANSI A-41.2.
- o American Standard Building Code Requirements for Masonry,
ANSI A-41.1.

Electrical

- o National Electrical Safety Code of the National Bureau of Standards (NBS)
- o National Electrical Code (NFPA No. 70, ANSI C1).
- o Institute of Electrical and Electronics Engineers - Standards
- o American National Standards Institute - Standards
- o Illuminating Engineering Society Lighting Handbook
- o Insulated Power Cable Engineers Association - Standards
- o Underwriters Laboratory, Inc. - Standards
- o Factory Insurance Association - Recommended Good Practice for Transformer & Switchgear Installation
- o National Electrical Manufacturers Association - Standards
- o Federal Aviation Regulations (for obstruction lighting).

Flood Design

- o Civil Engineer Bulletin No. 52-8, Revised March 1965, Office of the Chief of Engineers, Dept. of the Army.

Heating, Ventilating and Air Conditioning

- o American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals.

Air Filters and Installations

- o ORNL-NSIC-65, Filter Handbook.

and
Piping / Plumbing

- o U. S. Public Health Service Publication 525, "Manual of Recommended Water Sanitation Practice."
- o National Plumbing Code, ANSI A40.8.
- o Power Piping, ANSI B31.1.0.

Fuel Gas Systems

- o American National Standards Institute, "Installation of Gas Piping and Gas Appliances in Buildings, ANSI Z21.30.

- o American National Standards Institute, "Gas Transmission and Distribution Piping Systems," ANSI B31.8.

Compressed Air and Fuel Oil

- o American Society of Mechanical Engineers, "Unfired Pressure Vessels, Section VIII."
- o API Standard 620 for Large, Welded, Low Pressure Storage Tanks, 1966.

Fencing

- o AEC Manual Appendix 2401, Part II, C.3.a.

Railroads

- o American Railway Engineering Association (AREA) Standards.

3.2 Site and Environs

3.2.1 Concept-Related Design Requirements and Design Assumptions

The basic siting requirements for a high-level waste repository are cited in Sect. 2.1.2, and these requirements are applicable to a BSPP which may be developed into an operating repository. Salt deposits are extensive in the continental United States, underlying ~500,000 sq mi in portions of 23 states. One of the more promising regions for establishment of a pilot plant repository in bedded salt is that part of the Permian basin in southeastern New Mexico which contains extensive evaporite deposits in the appropriate thicknesses and depths. An extensive site investigation program has been initiated in southeast New Mexico. The results of this investigation were not available when the engineering conceptual design was made, and an assumed site was used as the basis for the concept. When the site investigation program results in a site selection for the BSPP, the design assumptions made relative to the assumed site must be evaluated and any resulting changes factored into the concept.

3.2.2 Location and Site Description

The region which has been selected for more intensive investigation is a four-township area located in Eddy and Lea Counties, some 25 miles east of Carlsbad, New Mexico and comprises portions of townships 21-22S, ranges 31-32E. Potash minerals have been extracted in the general area for approximately 40 years. Figure 3.1 shows an index map of the area. The topography can be broken down into four major divisions: foothills of the Guadalupe Mountains, the high plains, isolated areas of low hills, and widespread

LOCATION MAP OF STUDY AREA AND ASSUMED SITE
Fig. 3.1

pediments and alluvial plains. These topographic provinces are locally modified by collapse features. It is an area of sandhills covered by mesquite and associated plants of the Chihuahuan vegetation type at the northern end of the Chihuahuan Desert. Altitude ranges from 3000 to 3900 ft above sea level.¹ Over most of the general area the ground surface has low relief and slopes gently away from the Guadalupe Mountains and the High Plains toward the Pecos River or locally toward Black River and Monument Draw.

The climate of nearly the whole region is semiarid. The average annual precipitation ranges from about 12 to 13 inches near the Pecos River and Jal to almost 16 inches at Hobbs. In the Guadalupe Mountains, precipitation rises to about 22 inches near the summit. Most precipitation is from local thundershowers that occur from June to October. The variation in the yearly total is large.

The relative humidity in the region is low. Winters are mild with little snow, and summers are warm. The average July temperature in the region is a little over 80°F. Windstorms, mainly in the spring of the year, may be severe.

Mineral production in Eddy and Lea Counties has been nationally significant, and, as of 1967, Lea County ranked first in the State in value of production. The petroleum, gas and potash industries have dominated the economies of the two counties for several decades.

The tentative site assumed for the BSPP conceptual design is located in Eddy and Lea Counties and is comprised of: Sect. 1 and east half of Sect. 2 of Township 22, Range 31E; west half of T22S, R32E; southeast quarter of Sect. 35 and south half of Sect. 36 of T21S, R31E; and southwest quarter of Sect. 31 of T21S, R32E. Dimensions are two miles in the east-west direction by one-and-a-half miles north-south. Elevations at the site range from about 3450 ft above sea level at the southwest corner to about 3570 ft along the southeastern sector.

The land and associated subsurface mineral rights over the storage areas will be withdrawn from public use, subject to existing easement for public roads and highways, public utilities, railroads, and pipe lines. A buffer zone will surround the storage area. All subsurface mineral rights will be acquired in the buffer zone adjoining the storage area.

3.2.3 Transportation

The region is readily accessible by highway, railroad, and scheduled air service, although the assumed site is undeveloped with no roads or railroads. The potash mining areas to the northwest and southwest of the site are served by hard-surface State or Federal highways that provide easy year-around access from Carlsbad. U. S. Highway 62-180 runs generally east-west 28 miles north of the site; State route 128 runs generally east-west 28 miles to the southwest. Unimproved roads and jeep trails frequent the region.

Spur lines of the Santa Fe Railroad serve the mines, connecting via Carlsbad with the main line at Clovis, New Mexico, about 180 miles to the northeast. Figure 3.2 shows existing spur lines to the north and southwest of the assumed site.

Carlsbad has scheduled air service to El Paso, Albuquerque, and Dallas-Ft. Worth via Texas International Airlines.²

3.2.4 Population

The general area is sparsely populated; except for widely scattered ranch and farm dwellings the only population centers within 50 miles of the site are: Carlsbad (about 20,500*), Artesia (10,300), and Loving (1200) in Eddy County (total population 39,800); and Hobbs (25,800), Lovington (8900), Eunice (2600) and Jal (2600) in Lea County (48,000 total).

3.2.5 Stratigraphy, Geologic Structure and Tectonics

The region includes the northern end of the Delaware basin, a late Permian depositional trough whose edge is commonly defined as the front of the largely buried Capitan Reef. The entire sedimentary sequence includes strata from Ordovician through Quaternary age and has a total thickness in excess of 20,000 ft, with up to 13,000 ft of Permian strata. The oldest rocks exposed in the area are of late Permian age, but abundant information on older rocks is available from drilling.

*Population estimates Rand McNally & Co., Jan. 1, 1972.

ORNL DWG. 73-5858R1

GEOGRAPHICAL MAP OF STUDY AREA
Fig. 3.2

The strata in the region have been tectonically stable since Tertiary time and are only slightly deformed. The principal structural units are large-scale features related to late Paleozoic sedimentation: the northern Delaware basin, the shelf north and west of the basin, and the central basin platform to the east. These structures were tilted slightly eastward during Tertiary pre-Pliocene time, resulting in a regional eastward dip of from 1 to 2°.

The salt deposits of the area are contained in the late Permian Ochoan series, which is divisible into two parts: a thick lower section of salt-bearing evaporites including (in ascending order) the Castile, Salado, and Rustler formations and a thinner section above composed of the Dewey Lake redbeds (ref. Fig. 3.3).

The Castile formation consists largely of interlaminated gray anhydrite and brownish-gray limestone, but it contains a large percentage of rock salt. It has a thickness of about 1500 to 1600 ft along the southern edge of the region, thins northward to about 1000 ft near the margin of the Delaware basin, and tongues out in the southernmost parts of the northwest shelf.

The Salado formation, the main salt-bearing unit of the area, ranges in thickness from about 1900 ft in the south to about 1000 ft at the northern edge. The formation is characterized by thick persistent units of rock salt alternating with thinner units of anhydrite and polyhalite. Thin seams of claystone underlie the anhydrite and polyhalite units, and a few beds of sandstone and siltstone are present at large intervals.

Fig. 3.3 GENERALIZED GEOLOGIC SECTION AT THE ASSUMED BEDDED SALT PILOT PLANT REPOSITORY SITE, EDDY COUNTY, NEW MEXICO

The Salado formation is divided into three informal units: a lower salt member, a middle potassium-bearing member known locally as the McNutt potash zone, and an upper salt member. The three members are similar in most respects except for the occurrence of economically significant deposits of sylvite (KCl) and other potassium and magnesium evaporite minerals in the McNutt zone.

The Rustler formation, which is the uppermost salt-bearing unit in the Ochoan series, is 300 to 400 ft thick in the southern part of the area and thins to about 200 to 250 ft in the north. It is mostly anhydrite and rock salt. Some dolomite is present in the upper and lower parts of the formation, and thin to thick units of sandstone and shale are interbedded at long to short intervals.

The Dewey Lake redbeds at the top of the Ochoan series consist of reddish-brown siltstone and fine-grained sandstone. The formation is 250 to 550 ft thick in the area.

3.2.6 Hydrology

Three main hydrologic units control the ground-water hydrology of the southeastern New Mexico area. These are: (1) the Pecos River, which receives the ground-water outflow from the potash mining area; (2) the water-bearing strata overlying the Salado formation; and (3) the Capitan limestone and other water-bearing strata underlying the Salado formation. The distribution and development of large solution features, particularly in the Nash Draw and Clayton Basin areas, exert a major effect on the occurrence and movement of ground water.

The Pecos River receives nearly all the natural discharge of ground water that moves through the rocks of the potash mining area. The principal places of natural ground-water inflow are at Carlsbad, where water derived from the Capitan limestone discharges to the river or to the alluvium bordering the river, and near Malaga Bend, where highly mineralized water is discharged from the Rustler formation to the river.

The main aquifers or water-yielding units overlying the Salado formation are the Culebra and Magenta dolomite members and basal solution breccia zone of the Rustler formation, the Santa Rosa sandstone, and the alluvium. The Culebra dolomite member, which occurs throughout much of the area, is the main source of water tapped by stock wells.

The formations above the Salado seem to be connected hydrologically and can be treated as a single multiple aquifer system. The degree of development of the aquifer system is not known and cannot be determined from the existing hydrologic information, although the levels of water standing in wells are sufficiently uniform that potentiometric and water table contours can be constructed throughout the area. Dissolution activity and associated collapse, subsidence, and fracturing have increased the overall permeability of the rocks and have enhanced the interformational movement of water in the aquifer system. In the area, the aquifer system seems to be best developed between the Rustler and alluvium formations.

Ground water in the formations above the Salado moves generally southward and southwestward across the potash mining area toward the Pecos River. Although the total amount of ground water discharging to the

Pecos River is not known with any degree of confidence, it has been estimated that 200 gpm enter the river from the basal solution breccia zone near Malaga Bend.

3.3 Architectural and Structural

The architectural design of BSPP structures will be based upon criteria set forth in AEC Appendix 6301. Austerity and economy of construction will be the dominant guidelines in the selection of types of construction and architectural details. These guidelines will be tempered by operational and safety considerations where these factors take precedence in the design of the pilot plant structures. In addition, mining safety requirements dictate that all structures within one hundred feet of a mine shaft be of noncombustible construction and be provided with automatic fire control devices. See drawing C-102-3 for locations of structures.

3.3.1 Concept-Related Design Requirements

Section 2.1 provides definition of design classification categories for all pilot plant structures. Table 3.1 lists all BSPP areas and the design category for each. As safety analysis work is advanced it is conceivable that some of the categories may be changed.

3.3.2 General Considerations

As stated in Subsect. 2.5.2, structures form an integral part of confinement systems and must fulfill some of the requirements listed therein for these systems. To enable the ventilation systems to maintain the required negative pressures in confined areas, structures must minimize air in-leakage. Means used to reduce air in-leakage will include:

- o Selection of construction materials for minimum leakage.
- o Provision for sealing all structural connections and joints where leakage could occur.

Table 3.1
Design Classifications

Areas	Design Classifications		
	Category I	Category II	Category III
Receiving building areas:			
Transfer cell	x		
Operating gallery	x		
Cask unloading area		x	
Transfer gallery	x		
Cage loading compartment	x		
Waste concentration room	x		
Waste casting room	x		
Mechanical equipment room	x		
Tank pit	x		
Exhaust fan-filter house	x		
Waste shaft sheave house	x		
Chemistry laboratory			x
Personnel check station			x
Counting room			x
Office			x
Change room			x
Maintenance and storage room			x
Electrical equipment room	x		
Diesel generator rooms	x		
Central control and monitor room	x		
Decontamination equipment room	x		
Rail car air lock		x	
Battery room	x		
Waste shaft	x		
Waste shaft hoist house and cable enclosures		x	

Table 3.1
Design Classifications
(continued)

Areas	Design Classifications		
	Category I	Category II	Category III
Mine operations and administration building (all areas)			x
Warehouse			x
Staging building			x
Main shaft		x	
Main shaft headframe		x	
Man and materials hoist house		x	
Mine air supply fan house			x
Mine exhaust shaft	x		
Central filter station	x		
Mine escape shaft			x
Gatehouse			x
Mine areas:			
Receiving station cell	x		
Receiving station operating gallery	x		
Man and materials station			x

- o Use of air locks and gasket-sealed doors.
- o Close supervision of construction.

The added loads on structures due to differential pressures in confinement systems will be taken into account in design.

A thorough soil investigation will be conducted prior to detail design and the recommendations of a recognized soils engineer will be the basis for all foundation design.

3.3.3 Waste Receiving Building (Drawings A-101-3 and A-102-3)

3.3.3.1 Functional Description.--The waste receiving building will receive shipping casks on rail cars or trucks which will pass through the rail car air lock into the cask unloading area. Electrical interlocks will be provided to prevent both air lock doors from being open simultaneously. The cask unloading area will be a high-bay crane runway for handling of the shipping casks. A 110-ton capacity bridge crane with a 15-ton auxiliary hook will be provided for cask handling.

In the initial construction a single cask cooling station with a service platform will be provided for making cooling piping connections to the cask. The cooling and, if necessary, decontamination of the canisters within the cask will be performed at this station. Floor space will be provided for future installation of a second cask cooling station. An access hatch leading to a below-grade transfer gallery will be provided in the floor of the cask unloading area.

The operating gallery adjacent to the transfer cell will be the primary observation and control point for operations within the transfer cell. Three viewing windows and three pairs of master-slave manipulator sleeves will

be provided in the transfer cell shielding wall. Sufficient width will be provided in the operating gallery to allow removal and replacement of manipulators.

A waste casting room (for BSPP-generated waste) will be located on the ground floor level over the waste concentration room, and will have an air lock to the outside. An equipment air lock will be located over the decontamination equipment and cage service room, with a hatch into that room.

The exhaust fan-filter house adjacent to the waste receiving building will provide space for all the primary and secondary confinement exhaust fan and filters, with sufficient space surrounding them for ductwork, dampers, controls, and access for filter maintenance.

A covered tank pit, for tanks associated with the on-site waste collection and concentration system, will be adjacent to the basement.

3.3.3.2 Space Requirements.--Space requirements will be determined by the functional use of the areas. The rail car air lock and the rail car space in the cask unloading area will each be sized to accommodate a rail car of approximately 66 ft in total length, and to provide working space around the car. The height of the cask unloading area will be determined by the clearance required for the 110-ton crane to handle the casks. The length and width of the cask unloading area will be based on crane hook travel limitations, provision for cask laydown space and the required operating clearance for the hatch cover.

The transfer gallery, transfer cell, equipment rooms and exhaust fan-filter house will be of minimum size to accommodate efficiently the functions planned for them. The support facility areas are sized in accordance with the guidelines of AEC Appendix 6301. The building areas will be approximately as follows:

Waste receiving building, including basement	28,375 sq ft
Exhaust fan-filter house	<u>3,550 sq ft</u>
Total building area	31,925 sq ft

Approximate net areas conceived for each of the spaces in the waste receiving building are given in Table 3.2, along with room finishes and general construction materials. All exterior surfaces will have protective coatings in accordance with AEC Appendix 6301.

Design of the waste receiving building will provide suitable separation joints between areas of different loading conditions; mat-type footing design will be used for all bearing walls; and spread footings and grade beam construction will be employed where suitable. The bottom of all footings will be located below the prevailing frost line.

For the purpose of design the waste receiving building can be subdivided into six basic elements:

- a. Transfer cell.--The transfer cell wall and roof thickness will be dictated by shielding requirements and, thus, will be of a massive concrete design. Because of the mass and proportions of the structure and deep embedment in the earth, the structure will have a completely different response to dynamic seismic loading than the surrounding structures. For this reason, it will be physically separated from the surrounding buildings. A suitable flexible joint will be provided between all connecting zones.

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Table 3.2. Waste Receiving Building Architectural and Structural Details

Room	Approx. Area (Net) ft ²	Room Finishes			Materials of Construction
		Walls	Floor	Ceiling	
Cask unloading area	2,540	Note 1	Note 1	Painted	Structural steel framing, corrugated metal decking with built-up roofing over a vapor barrier and rigid insulation. Concrete block walls spanning horizontally between building framing columns.
Rail car holding area	1,380	Note 1	Note 1	Painted	
Transfer cell	585	Note 1	Note 1	Note 1	Reinforced Concrete
Shcave house	125	Note 1	Note 1	Note 1	
Transfer gallery	1,515	Note 1	Note 1	Note 1	
Mechanical equipment room	2,230	Note 1	Note 1	Note 1	
Electrical equipment room	2,750	Unfinished	Note 2	Unfinished	
Diesel generator rooms	1,385	Unfinished	Note 2	Unfinished	
Central control & monitor room	255	Painted	Asphalt tile	Painted	
Waste concentration room	525	Note 1	Note 1	Note 1	
Battery room	80	Unfinished	Note 2	Unfinished	
Tank pit	1,250	Note 1	Note 1	Note 1	
Operating gallery	670	Note 1	Asphalt tile	Note 1	Reinforced concrete floor, walls, and roof. Built-up roofing over a vapor barrier and rigid insulation.
Waste casting room	734	Note 1	Note 1	Note 1	
Chemistry lab	245	Painted	Vinyl covering	Painted	Reinforced concrete floors. Concrete block walls and partitions (8-in. bearing walls and 6-in. partition walls). Hollow-core prestressed concrete planking roof - with acoustical ceiling finish. Built-up roofing over a vapor barrier and rigid insulation.
Personnel check station	175	Painted	Vinyl covering	Painted	
Counting room	240	Painted	Vinyl covering	Painted	
Office	140	Painted	Asphalt tile	Painted	
Change room	365	Tile wainscot; paint above	Ceramic tile	Painted	
Maintenance & storage room	505	Unfinished	Note 2	Unfinished	
Rail car air lock	1,330	Unfinished	Note 2	Unfinished	
Support area corridors	335	Painted	Asphalt tile	Painted	
Exhaust fan-filter house	3,345	Note 1	Note 1	Note 1	
					Below-grade reinforced concrete

Note 1: Surface to be treated with an easily decontaminable surface finish.

Note 2: Floor to be treated with a floor hardener wearing surface.

To evaluate the action of this structure under seismic loading, a dynamic analysis will be conducted during the detail design to consider the soil-structure interaction. The results of this analysis will be used in the foundation design and in determining anchorage and mounting requirements for the vital equipment located within the cells.

- b. Operating gallery and waste casting room.--The operating gallery will be located along one side of the transfer cell and the waste casting room nearby. The design of the walls and roof of these rooms will be controlled by the tornado loading, which will create an internal pressure due to the barometric pressure drop. The rooms will be reinforced concrete for confinement and protection against tornado-generated missiles.
- c. Transfer gallery, basement areas, tank pit, and exhaust fan-filter house.--These areas are all located below grade and thus will not be subject to the direct wind loading from a tornado. They will, however, be subjected to the 3 psi pressure differential; therefore, the top cover slab will be designed to resist this loading. Since the structures will be embedded in the ground, they will assume the same acceleration as the surrounding earth during a seismic event. This acceleration will be considered in the design of the anchorage of critical equipment.

- d. Sheave House.--The waste receiving building will not have a head frame over the mine shaft in the conventional sense. Instead, a sheave house will be provided as a part of the transfer cell to house the dual cable sheaves. Cable penetrations through the sheave house floor slab will be a source of radiation shine when a waste canister is in the shaft. The radiation will be attenuated by constructing the sheave house of concrete, properly reinforced for tornado and earthquake protection.
- e. Cask unloading area.--Roof support columns of the cask unloading area will be designed to carry the weight of the roof dead load and live load plus the lateral loads from wind, seismic effects, and lateral thrusts resulting from crane operation as specified in the AISC specification. The concrete block walls will span horizontally between the building columns. Overall lateral loads will be resisted by a diagonal steel bracing system in the roof framing that will carry the loads to the side or end walls, which will then act as shear walls. This type of construction, for lateral load classification purposes, is described as a "building with a vertical load-carrying space frame." Deflection of the block between columns and deflection of the overall building will be considered in the design to preclude cracking of the joints between concrete blocks due to lateral loading. Vertical control joints will be provided as necessary.

To eliminate the extreme eccentricities which would result if both building and crane columns were designed as a single member, independent crane columns will be provided for the crane runway. The crane columns will have bracing between them to resist longitudinal thrusts from the crane as required by the AISC specification.

The cask unloading area will be structurally separated from adjoining parts of the waste receiving building, since each will have different dynamic characteristics. Suitable seal-type flexible expansion joints will be used at all separation joints between confinement areas.

- f. Support facilities area and rail car air lock.--These areas will follow conventional design practice using the Uniform Building Code as a guideline. Preliminary investigation indicates that wind loading, rather than seismic loading, will be the dominant design lateral load. Connections of the precast roof panels will be such that the roof will act as a diaphragm to transmit lateral loads to the shear walls.

3.3.3.3 Design Alternate.--To eliminate the rail car air lock and the necessity to make the cask unloading area a confinement area, an arrangement putting the cask cooling stations on the same elevation as the transfer gallery has been considered. Further study of this arrangement is recommended. Use of air bearing pallets or skids for moving shipping casks, which are placed on the pallets in an upright, vertical position, would allow freedom of movement on one level without

the use of a crane. If the 110-ton bridge crane were used to remove the cask from its rail car and lower it immediately onto an air pallet in an air lock at the transfer gallery elevation, there would be no need for the cask unloading area to be a confinement area and there is no need for a rail car air lock. The cask unloading area would be smaller than shown on A-101-3, but more space would be required at the transfer gallery elevation. The physical arrangement of the cask cooling area and the transfer gallery must be such that personnel working in the cask cooling area will be protected from radiation exposure from the cask transfer access port in the transfer cell.

3.3.4 Waste Shaft and Hoist House (Drawings A-101-3 and A-102-3)

3.3.4.1 Waste Shaft.--The waste shaft is assumed for this concept to be 4 ft ID. A one-foot-thick reinforced concrete liner will be placed inside a 6-ft diameter shaft in the rock. Concrete bearing rings will be placed at appropriate intervals throughout the shaft. Dual cage guides will be fastened to the concrete liner and will have an abrasion-resistant steel surface. Excavation for the 6-ft diameter hole will be made by drilling from the surface. A pilot hole will first be drilled to full shaft depth, and this hole will be enlarged to the full 6-ft shaft diameter by boring with a full-size bit.

3.3.4.2 Hoist House.--The hoist house will enclose the waste shaft hoist drum, drive motor, and controls. A portion of the hoist house will be partitioned off to provide a control room for the operator. This will make it easier to provide satisfactory environmental conditions for operations and will aid in controlling contamination. For use during maintenance, a fixed monorail will be installed over the hoist drum and an equipment access hatch with a removable cover will be built into the roof.

A minimum contact angle must be provided between the hoist cables and sheaves. This angle dictates the elevation of the hoist with respect to the sheaves. Since the sheaves will be mounted in the sheave house above the transfer cell, the arrangement results in the hoist house being partially below grade. About 1200 sq ft will be required. Construction of the hoist house will be as follows:

- o Reinforced concrete foundation, floor and below-grade walls.
- o Concrete block walls and partitions above grade (8 in. bearing walls and 6 in. partition walls) with safety plate glass in upper part of control room partition.
- o Hollow-core prestressed concrete planking roof with acoustical ceiling finish.
- o Built-up roofing over a vapor barrier and rigid insulation.

The walls, floor, and ceiling of the hoist house are to be treated to provide a smooth, easily decontaminated surface finish.

3.3.4.3 Cable Enclosure.--Confinement of the hoist house and hoist cables will be provided to prevent the transfer of radioactivity from the cables to the environment under normal operating conditions. The cables will be confined in a steel enclosure from the sheave house outer

wall to the hoist house outer wall. The enclosure will be sized to accommodate the 1-1/2-degree fleet angle of the cables; it will be supported by a series of A-frame bents.

The interior of the cable enclosures will be treated to give an easily decontaminable surface finish, and the exterior will be painted for corrosion protection.

3.3.5 Mine-Level Receiving Station (Drawings M-108-3 and M-109-3)

The mine-level receiving station has two principal areas: the shaft station and the operating gallery. The shaft station will be directly under the waste shaft and below the mine floor so the waste transporter can be parked over it for receiving a waste canister. To provide visual observation of the waste canister transfer operation, the operating gallery with its viewing window and manipulators will be located toward the lower portion of the shaft station. Normal access to the operating gallery will be via stairs from mine level with a tunnel and ramp providing a secondary exit; access to the shaft station will be provided by air locks into its upper and lower portions.

Net volume of the shaft station will be ~6,000 cu ft and net floor area ~200 sq ft. The operating gallery will be ~272 sq ft net area, and air locks and corridors ~360 sq ft. Ports through the wall separating the shaft station and the operating gallery will accommodate a viewing window, manipulator sleeves, and other sleeves for a periscope and such tools as are developed in Title I and II design.

The operating gallery, accesses into it, and the mine space adjacent to the waste shaft and over the shaft station will be considered normally occupied zones and the radiation shielding of the shaft station will be designed to give radiation dose levels as stated in 2.2.2.2.

The bulk of the shaft station will be of massive concrete construction to provide radiation shielding, with higher density materials used judiciously where space restrictions justify their higher cost. Construction of the operating gallery and accesses will be reinforced concrete. Structural design and construction of the mine-level receiving station must allow for the loads imposed by the overburden and the creep, or salt flow, of surrounding material during the service life of the station. The preliminary conceptual design includes a space between the walls of the station and the surrounding salt which will be filled with a low-density, crushable material to provide a cushion to absorb the salt movement. Walls, floors and ceilings of the shaft station, the air locks into the shaft station and the operating gallery will be treated to provide an easily decontaminable surface.

3.3.6 Main Shaft, Hoist House, and Staging Building (Drawing MI-11362-EC-012-E)

3.3.6.1 Main Shaft.--The main BSPP mine shaft will be 14 ft inside diameter, having a reinforced concrete liner. A concrete partition will separate that portion of the shaft (≈32 sq ft) which is to serve as a mine air supply duct, and metal partitions will form compartments for the hoist, counterweight, manway ladder and utilities. Concrete bearing rings will be placed at appropriate intervals to support the shaft liner. The man and materials (M&M) hoist cage compartment will be ≈9-1/2 ft X 7-1/2 ft. Ladders in the manway will be ≈12 in. wide and will be offset with a landing every 10 ft. The tail of the shaft will extend ≈90 ft below mine level to provide means for loading salt into the hoist skip during excavation. A sump for dewatering will be provided at the bottom of the shaft.

Construction of the main shaft will be by conventional means, using drilling, blasting, and mucking techniques. Overbreak will be adequate for full liner thickness, which will be poured in stages as the shaft is sunk.

3.3.6.2 Hoist House and Head Frame.--The main shaft hoist house will have about 1300 ft² of floor area to house the hoist machinery and its main control station. The foundation and floor will be reinforced concrete construction. Walls will be concrete block (80in.-thick bearing walls and 6-in.-thick partitions) and the roof will be hollow-core prestressed concrete plank with builtup roofing over rigid insulation and a vapor barrier. If engineering studies during Title I show an economic advantage in doing so, the hoist house will be built partially below grade with partial reinforced concrete walls. The added cost of the subgrade hoist house construction must be weighed against the cost of the height of the head frame necessary to get the required contact angle between the hoist cable and sheave. The concrete floor will be given a treatment to provide a hardened wearing surface. Exterior walls will be painted with a water resistant paint, and interior walls and ceiling will be unfinished.

The main shaft head frame will be designed to support a hoist load comprised of a future 15-ton loaded salt skip and a man cage adequate for 17 men. Head room and clearances will be designed into the head frame for future installation of: the salt skip; provisions for dumping the skip; and a 100-ton salt surge bin into which the skip will be dumped. A roof and siding will be provided for the head frame to keep precipitation from entering the shaft. Cost studies during Title I will determine the materials of construction for the head frame.

3.3.6.3 Design Alternate.--Preliminary conceptual studies indicate a possible advantage in using a Koepe winder hoist for the main shaft instead of a conventional hoist and head frame. This concept will require the hoist house to be located over the shaft at the top of the head frame. Additional engineering study and economic evaluation will be necessary to determine if this is a more economical concept.

3.3.6.4 Staging Building.--The staging building will provide a place to assemble men and materials entering the mine. About 2000 sq ft of space will be required comprised of: a covered loading dock and cage loading area; a room for temporary storage of mine materials; a remote auxiliary hoist control room; and a miners' lamp storage and repair room. Construction of the staging building will be:

- Reinforced concrete foundation and floor.
- Concrete block walls and partitions (8 in. bearing walls and 6 in. partition walls).
- Hollow-core prestressed concrete planking roof.
- Built-up roofing over a vapor barrier and rigid insulating.

The interior and exterior walls of the staging building will be painted. Floors will be concrete, finished with a floor hardener. Ceilings will be unpainted.

3.3.6.5 Man and Material Station.--The man and material station will be an unloading and loading room at mine level for the M & M hoist cage. It will be about 2500 sq ft in area, separated from the mine by an air lock. This station and the air lock will allow loading and unloading

the cage with men or materials without violating mine confinement. It will also serve as a safety room for personnel in event of an emergency in the mine. Construction of the station will be reinforced concrete with ample allowance for movement of the surrounding salt.

3.3.7 Mine Exhaust Shaft and Central Filter Station (Drawing HV-4)

3.3.7.1 Mine Exhaust Shaft.--The mine exhaust shaft will be a single-purpose shaft, 6-ft ID, with a concrete lining. Concrete bearing rings spaced at appropriate intervals will be installed throughout the length of the shaft. A concrete box structure at the base of the shaft will aid in supporting the concrete column.

Excavation will be by drilling a pilot hole the full shaft depth and then drilling to the gross shaft diameter using the pilot as a guide.

3.3.7.2 Central Filter Station.--The central filter station is to be located subgrade at the top of the mine exhaust shaft. It will contain about 2850 sq ft, composed of an inlet plenum chamber, three parallel filter trains, and a fan room. Construction of the filter station will be reinforced concrete with a built-up roof on the top slab. Access hatches over the inlet plenum and filter trains will have concrete shielding covers and steel cover plates. Hatches over the fan room will have steel covers. Framing for dampers and filters will be steel or stainless steel placed in formed concrete openings. Meticulous attention to structural details will be needed in design and construction of the station to provide satisfactory confinement and eliminate air leakage by the filters. All interior surfaces of the filter station will be treated to provide easily decontaminable surfaces.

3.3.8 Mine Escape Shaft

The mine escape shaft will be located in the same salt pillar as the mine exhaust shaft and will be excavated by drilling a pilot hole from the surface to mine level and upreaming to the full-size hole. This method of excavation is possible with this shaft because of its position in the construction sequence. The other shafts must be excavated before the mine opening is available; therefore, use of the upreaming technique for these other shafts is not possible, based on the preliminary schedule. After the hole is excavated it will be lined with concrete to 3 ft ID. At the lower end of the escape shaft a concrete box structure will help support the concrete column, and will form part of the structure of an emergency assembly room. This assembly room, of about 150 sq ft, will be a place to which underground personnel can gather in the event of an emergency if the route to the man and material station is not available.

Design Alternate.--It may be economically attractive to install the mine escape shaft inside the mine exhaust shaft, but isolated from it. This design alternate will be studied during the Title I phase.

3.3.9 Mine Operations and Administration Building

The mine operations and administration building will house all central administrative activities involved in the operation of the pilot plant as well as surface activities related to mine personnel and equipment. Office space will be provided for management, engineering, accounting, personnel, safety, and payroll functions and for files and records. Facilities for mine personnel will include change and shower rooms and a personnel check station. The design and construction of the building will be similar to that of

administration-type buildings on other Government projects for which a precedent of low construction cost has been established.

The mine operations and administration building will be connected to the staging building by an 8-ft wide covered passageway. The building will be located approximately 100 ft from the main shaft to provide adequate distance for shaft excavation and other facility construction and early construction of the administration building. Approximately 4700 sq ft of floor space will be provided.

Construction materials for the mine operations and administration building will be noncombustible, consisting of: concrete block walls and partitions (8-in.-thick bearing walls and 6-in. thick partitions), hollow-core prestressed concrete plank roof with built-up roofing over rigid insulation and a vapor barrier. All ceilings will be exposed and room finishes will be in accordance with AEC Appendix 6301 as follows:

- o Exterior and interior walls and ceilings painted in accordance with AEC Appendix 6301.
- o Floor finishes: corridors, offices, personnel check station, and records and storage - asphalt tile; toilets and change room - ceramic tile and tile wainscot; janitor's closets - exposed concrete with floor hardening wearing surface.

3.3.10 Mine Air Supply Fan House

The building will be approximately 600 ft² in area and will be designed to accommodate the mine air supply fan, its appurtenances and controls. Equipment and personnel access will be provided as required for functional use. The basic design criteria for architectural details will be AEC Appendix 6301. The building will be of conventional construction using the Uniform Building Code as the design guide. Concrete bearing walls will be 8 in. thick. Interior partitions, if any are required, will be 6-in.-thick concrete block. The roof construction will be gypsum roof plank over open-web steel joists with built-up roofing. The floor slab will be reinforced concrete treated with a floor hardener wearing surface.

3.3.11 Warehouse

The building will be approximately 165 ft long by 40 ft wide yielding a floor area of approximately 6,600 sq ft. It will have a nominal height of 12 ft. The building will feature open floor areas for working and storage space. The only partitioned spaces will be for office and toilet facilities. Vehicle and personnel doors will be provided as required for functional use. The basic design criteria for architectural details will be AEC Appendix 6301. The design and specifications for existing economical buildings of similar size and configuration constructed for other AEC facilities will be utilized to the maximum extent possible.

The building will be of conventional construction using the Uniform Building Code as the design guide. Eight-inch thick concrete block bearing walls will be used for the perimeter of the building with steel columns and beams for interior support. Six-inch concrete block walls will be used for interior partitions. Roof construction will be gypsum roof plank over open-web steel joists with built-up roofing. The floor slab will be of reinforced concrete treated with a floor hardener wearing surface. Exterior and interior walls will be painted in accordance with AEC Appendix 6301.

3.3.12 Gatehouse

The gatehouse will be a structure of approximately 400 sq ft located at the entrance to the pilot plant. It will be the main information and check point for all employees, visitors, and automotive traffic entering and leaving. It will be provided with all of the alarms and communication systems necessary for safeguarding and controlling access to the facility. All windows and doors will be glazed with laminated safety glass and have

protective grilles. Toilet facilities will be provided for the convenience of guards and visitors. The basin design criteria for architectural details, interior and exterior painting and floor finishes will be AEC Appendix 6301.

The building will be of conventional construction using the Uniform Building Code as the design guide. It will be a Category III structure as described in Section 2.1. Concrete block bearing walls will be 8 in. thick. Interior partitions will be 6-in. thick concrete block. The roof construction will be hollow-core prestressed concrete planking with an acoustical ceiling finish. A built-up roof will be provided over a vapor barrier and rigid insulation.

3.4 Mine Development

3.4.1 Design Assumptions

For purposes of this conceptual design the following assumptions were used for development of the mine plan:

- a. Waste storage rooms will be 18 ft wide and 17 ft high.
- b. A 100-ft buffer strip will be retained between waste storage or disposal operations and the repository boundary.
- c. The power density for waste storage will be 150 kW/acre of room-and-pillar area; entries, support areas, shaft columns and buffer strip (b. above) are not included in this acreage.
- d. The overall area for repository development will be three square miles.
- e. All mine equipment will be electrically powered except for the waste transporter.
- f. All mining anticipated for the life of the BSPP will be accomplished by the construction contractor before the start of BSPP operations.

3.4.2 Mine Layout

3.4.2.1 Master Plan.--The master plan for the mine was developed in accordance with the functional criteria set forth in section 2.3 and basic design assumptions above. The mine plan is shown on drawing MI-11362-EC-011-E. The overall mine layout is essentially a retreating room-and-pillar system converging onto the centrally located shaft area. To minimize capital funding for the BSPP, the pilot plant area is

located in the shaft area and as near the shafts as possible without affecting the conical shaft pillars. An area capable of storing ~25,000,000 cu ft of alpha-type wastes has been set aside for possible future use for this purpose. This space can also be utilized for burial of high-level wastes if it appears desirable during development of the full-scale repository.

Previous engineering studies have considered two alternative methods for disposal of waste in a salt mine repository. One concept is to bury the canisters in vertical holes drilled in the mine floor. This concept has been chosen for use in the pilot plant, modified to include storage inside a sleeve. The second alternative is to bury the canisters in holes drilled horizontally in the mine walls. Further study of the horizontal concept will be pursued prior to the design of a full-scale repository. The master plan has the flexibility to permit horizontal burial at some later date if this change proves to be technically and economically feasible. The master plan considers the broad spectrum of requirements including ventilation, mine opening stability, heating effects, efficient use of mining and hauling equipment, efficient use of the mine space created, and the excavation sequence.

A vital factor governing mine opening stability is opening size. The master plan for the mine is based on driving openings with cross-sections as small as possible, consistent with clearance

requirements for the mining methods and equipment and for efficient space utilization. Thus, widths of openings for this mine will not exceed 30 ft. Based upon rock mechanics analysis, this will insure the required stability of the openings. Cross sections of all openings will be rectangular. Although the most stable section would be circular, clearance requirements for equipment, particularly the waste transporter, make the rectangular configuration more attractive.

Development Sequence.--The BSPP mine will be excavated, along with the shaft and support area, prior to start of operation of the BSPP. If it is decided to expand the pilot plant to a full-scale repository at some later date, the burial plan would expand northward and eastward to the northeast corner of the site, retreat in the southeast sector from the eastern boundary to the shaft area, then start at the western boundary and retreat again to the shaft area in the northwest and southwest sectors.

3.4.2.2 BSPP Mine Layout.--For the purpose of developing a mine plan for the BSPP, it was assumed that 1000 canisters will be stored during pilot plant operation. The BSPP mine layout considers the requirements for determining the most economical method of developing an underground mine, minimizing initial excavation costs, and optimizing shaft locations for expanding the BSPP into a full-scale repository, if operating experience confirms that high-level wastes can be safely buried in salt.

The 50 storage rooms of the BSPP mine adjoin a main storage room entry as shown on drawing MI-11362-EC-011-E. The rooms are staggered to take maximum advantage of the shadow shielding offered by the salt pillars between rooms.

The area immediately surrounding the waste shaft features single-direction traffic for the transporter with a turn-around entry beyond the shaft. The shafts are located so that a minimum of 500 ft is provided between the mine exhaust ventilation and any surface building, and a minimum of 500 ft is provided between any exhaust stack and the site boundary.

3.4.2.3 Support Areas.--The support areas in the mine are grouped near the entry to the main shaft as shown on Fig. 3.4, and include rooms for equipment maintenance and repair, first aid, personnel assembly, and material and records storage. The maintenance and repair facilities will be utilized for service and minor repair of that mining and waste handling equipment which is too large to be moved easily to the surface. Major repairs will be done at the surface, following disassembly of the equipment as required to raise it via the main shaft. These support areas will have no special surface treatment of ceilings, floors and walls.

3.4.2.4 Alternate Mine Plans.--A study was made of alternative master plans for the mine. Four alternative arrangements were analyzed for operational and economic advantages and disadvantages, including calculations relating to efficient utilization of the mine space. Specific consideration was given to maximizing the waste heat accommodated per acre.

Fig. 3.4 MINE SUPPORT AREAS

3.4.3 Man and Materials Cage and Hoist

3.4.3.1 Man and Materials Cage.--The man and materials (M&M) compartment of the main shaft will accommodate a cage of the size shown on drawing MI-11362-EC-012-E and having capacity for 17 men. Provisions for future addition of a 15-ton overturning salt hoisting skip will be designed into the M&M cage. The cage will serve the BSPP and, in conjunction with the future salt skip, will be capable of supporting the early years of a full-scale repository at the same location. The hoist cage will be of steel and aluminum construction, fully enclosed on three sides, and with removable hinged doors on the fourth side for easier loading of materials. Safety dogs will be provided which will stop the cage in case of rope failure.

3.4.3.2 Man and Materials Hoist.--The M&M hoist will have a capacity of 15 tons and a design speed of 600 fpm. The hoist will have two independent disc brakes, hydraulically controlled. The safety installation will include Lilly controllers for over-speed and overwind and a dead-man switch. The winder drum will be located in a hoist house near the shaft. There will be provisions for semiautomatic control of the hoist, but it will be capable of being operated manually from a control room located in the staging building.

3.4.4 Salt Removal

Inasmuch as the conceptual design assumes that no BSPP storage rooms will be backfilled, all excavated salt must be moved to the surface and to a suitable disposal area. The estimated total quantity of salt to be removed from the mine during the initial BSPP development is ~500,000 tons. It has been assumed that this initial development will be accomplished as part of the construction contract, using mining and underground hauling equipment furnished by a contractor.

3.4.5 Thermal Considerations

Thermal emissions from the waste will heat the surrounding salt and adjacent formations. Differential expansion of strata will probably accompany movement of a thermal front through the formations. This could introduce adverse effects on the shafts such as wall cracks and misalignments. The most practical preventive measure is to place the heat sources as far as possible from the shaft locations. Thus the sequence of canister storage (pilot plant) and burial (full-scale repository) operations will work generally away from shaft locations and only finally return to the shaft pillar areas during the period of high-rate waste burial in the full-scale repository phase of mine operations. This sequence was developed to minimize the amount of initial development required, as well as to keep burial operations away from the shaft area until the final phase of mine utilization.

Theoretical calculations have been made to determine optimum storage conditions and waste canister spacing. The following conditions were set forth as temperature limits upon which to base the study:

- a. No more than 1% of the salt in any given unit cell (defined as a vertical "slab" of the mine bordered by the center lines of two adjacent waste canisters in a room in one horizontal direction, the center lines of the room and adjacent pillar in the other horizontal direction, and extending vertically 400 ft in either direction) shall be at a temperature greater than 250°C; and
- b. No more than 25% of the salt in this unit cell shall be at a temperature greater than 200°C.

These calculations indicate that the maximum permissible loading per gross acre of burial area (excluding shaft columns, support areas, entries, and space reserved for future alpha burial) corresponds to 150 kW/acre, which was used as the basis for the conceptual design.⁽¹⁾ The study also indicates that there is little difference in permissible loading imposed by variations in room size or in arrays of canisters within a storage or burial room. The conceptual design was, therefore, based on the very simple arrangement of a single line of waste canisters on the center line of a room 18 ft wide, which is the minimum size into which the currently envisioned waste handling equipment can maneuver conveniently. The spacing between waste canisters is dependent upon the waste heat generation per canister and the age of the waste.

(1) ORNL-4789, Thermal Analysis of the National Radioactive Waste Repository: Progress Through March, 1972, R. D. Cheverton and W. D. Turner, September 1972.

Buffers of undisturbed salt will be left in place between active storage and disposal areas and areas where present or future operations will be conducted during the life of the mine. The purpose of these buffers is to restrict the temperatures to which personnel will be exposed in performing future operations. These buffers will vary in thickness, depending on the time interval anticipated between storage or disposal operations on one side of the buffer and future personnel exposure on the other. A very generalized picture of the temperature rise vs time is shown on Fig. 3.5.

The studies discussed above will continue, with the possibility that basic parameters will be modified prior to start of Title I design.

Fig. 3.5 TEMPERATURE RISE vs TIME SINCE BURIAL FOR LOCATIONS
NEAR EDGE OF SOURCE REGION; 150 KW/ACRE FROM
SPENT LWR FUEL

3.5 Waste Handling System

The functions and design requirements for the waste handling system are enumerated in section 2.4. The system includes all the facilities and equipment necessary to safely receive, unload, emplace in a salt mine, and retrieve canisters of high-level radioactive waste.

3.5.1 Design Assumptions

The following assumptions were made on a basis for this conceptual design:

- a. The existing Project Salt Vault (PSV) transporter, currently stored at the Nevada Test Site, will be used as the BSPP waste transporter.
- b. Transfer of the waste canisters from the shipping cask to the facility shielded structures will be done at the surface.
- c. Recovery from unusual occurrences, such as canisters or casks contaminated above specified limits, damaged canisters, etc., will be effected by shutdown of normal operations. The shutdown will be prolonged as necessary to complete the recovery and cleanup of the facilities and equipment.

3.5.2 Physical Description of System

(Ref. dwgs. A-101-3, A-102-3, M-101-3, M-106-3, M-107-3, M-108-3, M-109-3, M-111-3 and M-112-3). The waste handling system, shown schematically in Fig. 3.6, includes four distinct operations, each of which can be described as a separate subsystem, as follows:

Fig 3.6 WASTE RECEIVING, HANDLING, AND STORAGE SYSTEM

3.5.2.1 Cask Handling.--This subsystem is contained principally within the waste receiving building, although the railroad spur approaching the building can be considered a part of the subsystem. Commencing with the arrival of a single heavy cask by rail (or truck) the operations involved are:

- o The rail car, with a cask containing canisters of waste, will be brought into the waste receiving building through an air lock. A car puller will be provided to move the rail car into the cask unloading area from the air lock, having closed the outer air lock door before opening the air lock to the cask unloading area.
- o An overhead crane will remove the cask from the rail car. The cask will be rotated from a horizontal to a vertical position and placed on the cask service platform located within the cask unloading area.
- o The cask will be monitored for transferable surface contamination. If the surface contamination of the cask exceeds DOT regulations, the cask will be decontaminated.
- o The cask interior atmosphere will be sampled for airborne radio-activity to determine if a waste canister has lost its initial integrity during shipping. If a canister failure is detected, the cask will be set aside for special handling when routine operations can be interrupted.

- If the cask interior indicates no abnormal contamination levels, coolant supply and return connections will be made to the cask jacket and established cooling procedures will be followed.
- After cooling, the cask will be lowered through an access hatch in the floor of the cask unloading area and onto an air mover in the transfer gallery, where the cask lid hold-down attachments will be removed.
- The air mover will be utilized to transport the cask to a position beneath the cask access port in the transfer cell and to elevate the cask seal against the underside of the cell.
- Coolant supply and return connections will be made again to the cask jacket to reduce the interior cask wall temperature prior to and during the waste canister unloading operations.
- When a shipping cask has been emptied of canisters, the cask shield plug will be replaced and the cask will be lowered and returned to a position beneath the cask unloading area hatch.
- The cask will then be checked for compliance with standards for external contamination, cleaned if necessary and returned through the cask unloading area to the rail car for shipment back to the waste processor.

Design Alternate. --An alternate concept will be considered in which the cask interior atmosphere sampling and cask cooling functions will be performed in the transfer gallery rather than in the cask unloading area. The building modifications that are required for this alternate are described in paragraph 3.3.3.3.

3.5.2.2 Canister Unloading and Transfer.--This subsystem includes all the operations involved in removing the waste canisters from the shipping cask, inspecting them and transferring them to mine level. The facilities which perform these functions include the shielded transfer cell, the cage loading compartment, the waste shaft and the shielded mine-level receiving station. All operations which involve handling the waste canister outside the shielded shipping cask will be conducted behind massive radiation shielding, using remotely operated equipment and shielded viewing windows.

- A remotely operated in-cell hoist will be used to raise the access port cover from its location in the transfer cell floor. Master-slave manipulators will be used to couple the hoist hook to the port cover.
- A rack for storing the access port cover and the shield plug will traverse under the port cover, the cover will be lowered onto the rack, the hoist hook released, and the rack moved clear of the port.
- The in-cell hoist will be utilized to couple and to raise the cask shield plug.
- The rack will traverse under the shield plug, which will be lowered onto the rack, the hoist hook released, and the rack moved clear of the port to expose the top of the shipping cask.
- The waste shaft cage, Section A, Drawing M-106-3, will be positioned beneath the cage access port and the port cover opened.

- The 4-ton crane in the transfer cell will be used to couple to a waste canister in the outer row in the shipping cask, raise the canister clear of the cask, move the canister over the cage access port and lower it into the waste shaft cage. Canisters will always be selected from the outermost row to take advantage of the radiant heat sink and cooling effect provided by the cooled cask wall.
- The connector will be released from the canister and the port cover closed.
- The waste shaft cage containing the waste canister then will be lowered down the waste shaft to the mine-level receiving station.
- At the receiving station, the waste shaft cage will be lowered to the cage unloading position at the bottom of the station, directly beneath a shielded transporter which will have been previously positioned over the access port and its shield lowered.

3.5.2.3 Waste Emplacement.--This subsystem includes transfer of waste canisters from the mine-level receiving station to storage holes in the salt mine and includes the following operations:

- The receiving station port cover will be opened and the lower transporter shield door opened.
- The connector will be lowered from the transporter to couple with the canister. A viewing window and a manipulator will be provided to assist in the attachment.
- The canister will be raised into the transporter, the lower shield door closed, and the transporter shield raised to permit

the transporter to move away from the receiving station to the storage room.

- o The waste shaft cage will be returned to the surface and positioned to receive another canister.
- o At the waste canister storage hole, the canister will be lowered into the sleeved storage hole and covered with a shield plug as shown in Fig. 3.7.

3.5.2.4 Waste Retrieval.--There are four reasons envisioned for removal of the waste from the sleeved holes in the mine:

- a. To demonstrate that the waste is retrievable should it become necessary. This demonstration would involve a small number of waste canisters early in the pilot plant operating history;
- b. To abandon the pilot plant site;
- c. To remove the waste canisters for direct burial in unsleeved, backfilled holes in a full-scale repository; or
- d. To remove a canister where there is evidence of its failure.

The retrieval procedure includes removal of the shield plug by remote operation, engaging the connector with the waste canister, and lifting the canister into the transporter.

3.5.3 Equipment Description

The equipment required to support the BSPP waste handling operations is discussed below. The equipment components related to the cask handling subsystem are located within the cask unloading area and the transfer gallery of the waste receiving building. Components related to the canister unloading and transfer subsystem are located within the waste receiving building transfer cell structure and the waste shaft. Waste emplacement subsystem components are located within the mine-level receiving station and the mine itself.

3.5.3.1 Cask Handling Subsystem

- a. Traveling Bridge Crane.--A 110-ton overhead bridge crane with a 15-ton auxiliary hook will be located over the cask unloading area in the waste receiving building. The crane will transfer the cask from the rail car to the cask unloading area and subsequently lower it through the access hatch onto the air mover located in the transfer gallery. The shipper/owner of the cask will furnish slings, bails, and other lifting devices, as required, to upend and remove the cask from the rail car and to replace the cask on the rail car after the waste canisters have been removed (ref. dwg. M-112-3).
- b. Rail Car Puller.--An electric-motor-operated single-drum, two-way car puller will be provided to move rail cars between the air lock and the cask unloading area. [This equipment will not be required in the case of the design alternate discussed in paragraph 3.3.3.3, which would eliminate the need for the rail car air lock].

- c. Hatch Cover.--A motorized cover will be provided over the access hatch through which the shipping cask will be lowered from the cask unloading area to the transfer gallery. The hatch cover will be approximately 14 ft square and will travel on rails embedded in the concrete floor of the cask cooling area.
- d. Air Mover.--A 120-ton capacity air mover will be provided within the transfer gallery to operate between the access hatch and the transfer cell cask access port (Ref. dwg. M-111-3).
- e. Lift Table.--A 120-ton capacity hydraulic lift table will be provided in the transfer gallery to elevate the shipping cask into sealing contact with the under side of the transfer cell cask access port (Ref. dwg. M-111-3).

3.5.3.2 Canister Unloading and Transfer Subsystem

- a. Transfer Cell Crane.--A remotely-operated 4-ton bridge crane will be provided in the transfer cell to remove waste canisters from the shipping cask and lower them into the waste shaft cage. Two 4-ton hoists will be provided on the bridge crane trolley. Each hoist will have sufficient drum capacity to complete a lifting or lowering operation should one hoist fail. Likewise, duplicate bridge and trolley drives will be provided (Ref. dwg. M-112-3).
- b. Transfer Cell Hoist.--A 15-ton hydraulically-operated bridge-mounted hoist with remote controls will be provided in the transfer cell. The hoist will be used to remove and replace the cask access port cover and shipping cask shield plug.

- c. Cask Access Port Cover.--A steel cover will be provided for the cask access port in the floor of the transfer cell to provide gamma shielding and an alpha seal between the transfer cell and the transfer gallery below.
- d. Storage Rack.--A remotely controlled traversable rack will be provided in the transfer cell for temporary storage of the cask access port cover and the shipping cask shield plug. The rack will be traversable to permit direct observation of cask and shield plug and cask access port cover handling operations.
- e. Cage Access Port Cover.--A remotely operated cover will be furnished for the cage access port to provide a closure between the transfer cell and the cage loading compartment at the top of the shaft.
- f. Waste Shaft Cage and Guides.--A cage will be provided to lower the waste canister down the waste shaft to the mine. It will be of open construction and will be provided with adaptors to center and orient vertically any waste canister between 6 in. and 24 in. o.d. The cage will be provided with guide wheels which will operate within cage guides installed in the cage loading compartment, the waste shaft and the mine-level receiving station.
- g. Master-Slave Manipulators.--One pair of extended-reach, heavy duty, master-slave manipulators will be provided to assist in performance of routine operations and maintenance functions within the transfer cell. Two additional pairs of manipulator sleeves will be provided for future installation of additional manipulators.

- h. Viewing Windows.--Three shielding viewing windows will be provided in the transfer cell wall to permit direct viewing of the cell operations. Gamma and neutron attenuation will be equivalent to that of the cell wall. The windows will be removable into the cell operating gallery for maintenance or replacement.
- i. Canister Connector.--A remotely operated connector will be provided to mate with the connector pin atop the waste canister (Ref. Appendix 11.2).
- j. Auxiliary Viewing Equipment.--Provision will be made for transfer cell auxiliary viewing equipment as follows:
- (1) Two closed-circuit television cameras will be located in the cage loading compartment to assist operating personnel in viewing the transfer of the waste canister into the shaft cage. The cameras will be oriented at 90° to each other in a horizontal plane. The monitor will be located in the transfer cell operating gallery (Ref. M-106-3).
 - (2) Sleeves will be embedded in the ^{transfer} cell wall for future installation of a periscope for special viewing problems. Location of the sleeves will be determined during Title I design.
 - (3) Mirrors will be mounted within the transfer cell to assist in viewing cell operations through the cell viewing windows.

- k. Repackaging Equipment.--A remotely operated system for repackaging a canister within an overcan will be provided. The equipment will not be installed in the transfer cell, but capability will be provided to insert the equipment through the cask access port for installation at a location provided within the transfer cell. Conceptual design of the repackaging equipment will be conducted in advance of Title I engineering.

3.5.3.3 Waste Emplacement Subsystem.--The waste emplacement equipment consists of the waste transporter and appurtenances to the mine-level receiving station. These equipment pieces are discussed below.

- a. Transporter.--The existing Project Salt Vault (PSV) waste transporter, with necessary modifications, will be used for BSPP operations. The necessary modifications are:

- o Provide for cooling water circulation around the existing lead shielding. In addition to cooling, the water will provide supplementary neutron shielding.
- o Lengthen the shielding cask by approximately one foot, allowing the cask to accept canisters up to 10 ft in length.
- o Provide ventilation blower and filter to maintain negative pressure and confinement within the cask.
- o Provide a two-inch Lucite shield around the cask. This shield is required for additional neutron attenuation during transportation of canisters with up to 4000 watts thermal power.

- o Provide scrubber for diesel exhaust fumes.
- o Provide new or larger tires as required.
- o Provide structural modification as required to accommodate increased weight of shielded cask.

The PSV transporter is currently stored at the Nevada Test Site.

- b. Port Cover.--A rolling cover will be provided for the access port in the floor of the transporter loading area to provide shielding from radiation from the shaft station and an alpha seal between the two areas. The port cover will be actuated by hydraulic pistons (Ref. dwg. M-108-3).
- c. Viewing Window.--A viewing window will be provided in the shield wall to permit visual verification from the adjacent operating gallery of the connection of the transporter connector to the waste canister. The window will provide gamma and neutron shielding equivalent to that of the wall in which it is installed.
- d. Manipulator.--A single-purpose manipulator will be installed to provide assistance in making the connection to the waste canister, if required. The manipulator will be sectionalized for ease of installation and removal into the receiving station operating gallery.
- e. Periscope.--A periscope will be provided in the receiving station cell wall which will permit viewing of portions of the cell interior which are not visible through the viewing window (Ref. dwg. M-108-3).

3.6 HVAC and Confinement (Drawings HV-101-3, HV-4, and H-11362-EG-012-E)

3.6.1 Concept-Related Design Requirements and Design Assumptions

The conceptual design of the BSPP is based on the assumption that the exterior surfaces of the waste canisters will have some level of transferable surface contamination (ref. paragraph 11.2.2.e) and that handling of the canisters outside of shipping casks, as well as exposure of the shipping cask internal surfaces and atmosphere, could result in a level of air-borne radioactivity and surface contamination which must be controlled to protect operating personnel and the public. It is further assumed credible that canister integrity can be violated, resulting in higher levels of activity which also must be controlled. Protection of operating personnel and the public will be achieved by the confinement systems (along with shielding systems) which serve primary and secondary confinement areas as defined in sect. 2.5.2. Design requirements related to these assumptions are also listed in sect. 2.5.2.

It was assumed for conceptual design that a supply of natural gas will be available at the site to serve as the basic heating energy supply, and that domestic heating oil will be trucked to the site and stored to serve as a backup energy supply in lieu of on-site gas storage capability. Electricity was also assumed available in sufficient quantity and at a low enough cost to provide power for air conditioning as well as space heating in certain areas.

3.6.2 Confinement Systems

3.6.2.1 Waste Receiving Building Confinement Systems.--Table 2.1, page 2-25, lists BSPP areas for which primary or secondary confinement will be required. Building construction details and the HVAC systems serving these areas must preclude air flow from confined to unconfined areas without filtration, and air flow from primary to secondary confinement areas. The nature of the BSPP is such that some of the primary areas cannot be separated from each other by physical barriers, and some of the secondary areas cannot be separated from primary areas. For example, the transfer cell must be open to the cage loading compartment, at least while transfer of canisters is in progress, and the cage loading compartment cannot be isolated from the waste shaft and the mine-level receiving station cell. Similarly, the hoist cables will prevent complete isolation of the sheave house, cable enclosure and hoist house from the cage loading compartment. Where situations such as these exist, the confinement systems will control the direction of air flow by maintaining air pressure differentials between the areas. The direction of air leakage between confinement areas not having direct connections will also be controlled by differential pressures. Drawing HV-101-3 depicts schematically the conceptual design of the HVAC systems for the waste receiving building, including the confinement systems. The primary confinement zone exhaust system (PC) will remove air from four areas: the transfer cell, the cage loading compartment, the waste concentration room and the waste casting room.

Air will be exhausted through parallel paths of the secondary confinement exhaust system (SC) from a number of areas. Tentative pressures to be maintained in each area and exhaust flow rates are shown on the drawing.

3.6.2.2 Waste Receiving Building HVAC System Equipment Descriptions.--The

basic system for space heating and cooling of the receiving building and the waste shaft hoist house is a circulating water system. Central heating and cooling units will heat or cool the water, and equipment located in various parts of the building will utilize the water for heating and cooling individual rooms or groups of rooms as appropriate. Outside air will be introduced in different areas of the building to provide appropriate ventilation rates for each occupied space and to keep airborne contamination at minimum levels. The incoming air will be heated or cooled depending on the outside air temperature and the occupancy requirements of the space being supplied, and will in most cases be filtered to minimize airborne particulate levels and to add life to the exhaust system filters. Air exhausted from the operating gallery and support areas will be used as ventilation air for the transfer gallery, waste concentration, and decontamination equipment and cage service rooms. Approximately thirty percent of the air supplied to the cask handling area will be outside air and the balance will be recirculated. Brief descriptions are given for major equipment and components of the HVAC-confinement systems.

o Heating Boiler.--The heating boiler will be a natural gas-lined

package unit having approximately 80 boiler hp capacity, with automatic control and safety system, and the capability of quick changeover to oil firing.

- o Water Chiller.--Cooling will be supplied by a central chilled water unit of approximately 90 tons capacity, having a water-cooled condenser. For standby cooling service, an air-cooled chiller of approximately 11 tons capacity will be used. The central chiller will be in the mechanical equipment room, with the evaporative cooler servicing the chiller located outside. The air-cooled standby chiller will also be in the mechanical equipment room, with ducts to bring in and return air for the condenser.
- o Air Handling Units.--See Table 3.3.
- o Exhaust Fans.--Ordinary exhaust fans to pull outside air into the spaces for combustion and heat and fume removal will serve the diesel generator rooms, the hoist motor housing, and the battery room.
- o Confinement Exhaust Systems.--Both the primary and secondary confinement systems will consist of dual filter-fan trains each having capacity for the system it serves, with cross-connecting ducts and dampers so that either filter train may be in service with either fan. Instrumentation and control equipment shall be included to monitor the condition of the systems continually and automatically bring the standby fan and filter train into service if confinement conditions are not being maintained.

TABLE 3.3
AIR HANDLING UNITS - WASTE RECEIVING BUILDING

Type	Space Served	Heating Coil	Cooling Coil	Heating & Cooling Coil	Filters			Capacity	Single or Dual
					30% NBS	90%	HEPA		
*OSA	Basement	X	--	--	X	X	--	20950 cfm	Single
OSA	Support Area	--	--	X	X	X	--	4300	Single
OSA & Recirculating	Maint. & Storage	X	--	--	X	--	--	2500	Single
Supply	Waste Concen. Transfer	--	--	--	X	X	X	4000 ea	Dual
OSA	Gallery & Cage Service Room	--	--	X	X	X	--	2800	Single
Recirculating	Operating Gallery & Waste Casting	--	--	--	--	--	--	--	--
	Waste Concen.	--	X	--	X	X	X	2500	Single
OSA & Recirculating	Cask Unloading	--	--	X	X	X	X	14800	Single
OSA & Recirculating	Rail Car Airlock	X	--	--	X	--	--	3300	Single
Recirculating	Transf. gallery	--	X	--	--	--	--	700 & 950	Single
Recirculating	Transf. cell	--	X	--	--	--	--	2320	Dual
Recirculating	Central Control	--	--	X	--	--	--	560	Single
Recirculating	Waste Shaft Hoist House	--	--	X	--	--	--	300	Single
OSA	Waste Shaft Hoist House	X	--	--	X	X	--	4850	Single
OSA	Exhaust Fan/Filter House	X	--	--	X	X	--	3200	Single

*OSA - Outside Air

The filter train for both primary and secondary systems will consist of 30% and 90% NBS filter, followed by 2 stages of HEPA filters. Separating space and fire screen stops ahead of each stage of HEPA filters will protect against loss of confinement due to fire. Design of the filter frames and the physical arrangement of the filter banks will be amenable to bagging of filters to decrease the spread of contamination, and the space arrangement should allow temporary shielding installation around the filters. The design capacity is 3900 cfm for each primary system filter-fan train and is 22,200 cfm for each secondary train.

- Backflow Preventers.--Backflow preventers shall be dampers or valves having positive closing characteristics when the normal air flow ceases. Allowable leakage rates must be established for each backflow preventer in Title II design as a part of the safety analysis.
- Ductwork.--Ductwork embedded in concrete will be stainless steel with welded joints and have a corrosion protection system. Ductwork not embedded will be galvanized steel using ordinary construction techniques for systems other than confinement systems. For confinement systems welded construction steel ductwork will be used with internal and external coating to provide corrosion protection and easily decontaminable surfaces.

3.6.2.3 Mine Confinement and HVAC Systems.--Capacity will be built into the BSPP system to provide sufficient cooling from ventilating air flow to maintain simultaneously any five of the storage rooms at a low enough temperature to allow personnel entry (maximum 90°F). The assumed heat load is 20 kW to each room from waste decay heat. Bulk temperature of the salt bed in which the mine is located is assumed 84°F. Systems for the mine are as follows:

- o Supply: Ventilation air for the mine will be supplied by a fan in the mine air supply fan house, located near the main shaft. Outside air will be drawn into the fan house through a large air intake equipped with a bird screen. A heating coil will be provided in the intake to temper the outside air to a minimum temperature of 50°F during cold weather. Hot water will be supplied to the heating coil from a heating system located in the staging building with circulating pumps in that building. A cooling coil in the intake will decrease summer supply air temperatures to provide inhabitable underground conditions. The cooling coil will be supplied with water from a closed circuit cooler installed near the fan house. Pumps in the fan house will circulate the cooling water. A roll-type filter ahead of the coils will remove large airborne particulates. The mine air supply will be discharged through a volume control damper into a 6-ft-diam underground duct which will convey the air to the mine supply air compartment of the main shaft.

The mine supply air will be monitored by a flow switch which will trip an alarm if the air flow is reduced below a pre-set minimum due to fan failure or other causes. The alarm will require manual silencing and be automatically reset once air flow is re-established.

The mine supply air will flow down the shaft until it reaches a point above the man and material station. About 2000 cfm of supply air will be ducted into the man and material station as ventilation for personnel. This air will exhaust to the surface through the hoist cage compartment. Filtering will not be provided for this exhaust air, since the man and material station will be separated from the mine by an air lock.

The bulk of the mine supply air (approximately 50,000 cfm) will flow from the supply air compartment into a 6-ft-diam tunnel. The tunnel will have a back flow preventer damper, and a throttle will permit the mine air supply to be shut off in case of fire. Air will be discharged into the mine and will flow through the mine corridors to the waste storage area. From the entry serving the waste storage rooms, the air will flow into the rooms and be exhausted from the rear of each room into the exhaust tunnel. Flow through the storage rooms will be parallel, with no recirculation to any part of the mine. Sufficient flow will be maintained from each room to keep the room pressure lower than the entry pressure. In five rooms ventilation flow rates will be maintained at rates high enough to allow personnel entry.

Any 5 of the 50 rooms can be selected for the higher ventilation flow rates. Portable blowers will be used in the auxiliary rooms for circulating air through the rooms and back into the mine.

- ° Mine-Level Receiving Station: Mine air at the rate of approximately 500 cfm will flow from the mine into the receiving station cell, through flow control and backflow preventer dampers. This air will be exhausted through the waste shaft to the waste receiving building primary confinement system, which will supply the motive power. The receiving station cell will be maintained at a negative pressure, as indicated on the flow diagram, with respect to the mine.

The receiving station operating gallery will be a heated and cooled work station. An air conditioning unit having an air-cooled condenser will dissipate heat from the operating gallery to the mine air through an air-cooled condensing unit. Heat will be supplied by an electric coil.

- ° Exhaust: Each waste storage room will have dampers to control air flow from the room into an overhead exhaust tunnel. The dampers will control air pressure in each storage room so that it is negative with respect to the entry. Those five rooms chosen at any time for maximum cooling will have a greater air flow through to the exhaust tunnel. The exhaust tunnels, uninhabited except for inspection and maintenance, will conduct the air to the mine exhaust shaft.

The top of the mine exhaust shaft will terminate in a plenum

chamber. Three filter train chambers, connected in parallel, will draw mine exhaust air from this plenum. Each filter train will be designed to handle 50% of the mine exhaust air flow volume and a 10% overdesign factor; thus, any two filter trains will handle the design exhaust air flow. Tight-closure dampers will be provided on the inlet of each filter train for isolating the train for maintenance. Two filter trains and their fans will normally be in operation while the third train of filters and fan may be serviced or held in standby condition. Standby power will be provided to operate any one of the three fans in the event the normal power fails.

Removable covers and ladder access for maintenance will be provided to work spaces upstream of the 30% filters, downstream of the 90% filters, and on both sides of the HEPA filters.

Normally, radioactive contamination will be sufficiently low that shielding will not be required when replacing filters, but the arrangement will allow for remote bagging and removal with the use of temporary shielding.

Differential pressure gauges will be installed on each side of each filter bank and will indicate when filter replacement is necessary. Each fan will have the capacity to handle 50% of the mine exhaust flow, with a sufficient static pressure head to overcome friction losses in the mine, shaft and stack, plus a reasonable buildup of filter resistance. Connections will be provided for in-place DOP testing of individual HEPA filter banks.

3.6.2.4 Mine Confinement and HVAC Equipment.--The principal equipment items are briefly described:

- ° Supply fan.--The supply fan will be a centrifugal fan, driven directly with a 60 hp electric motor, supplying 50,000 cfm at about 6 in. of water static head..
- ° Intake filter.--The mine supply air filter will be a roll type disposable filter, having a frame approximately 9 ft high and 14 ft long.
- ° Heating coil.--The heating coil will be a 2-row hot water coil, 8 ft high by 12 ft long.
- ° Cooling coil.--The cooling coil will be an 8-row water coil, 8 ft high by 12 ft long.
- ° Boiler.--The boiler will be a natural gas-fired package unit, of approximately 80 boiler horsepower capacity, with an automatic control and safety system, and the capability of quick change-over to oil firing.
- ° Water cooler.--The water cooler will be a closed circuit cooler of the evaporative-coil type, having four 7-1/2-hp fans and one 5-hp water spray recirculating pump. Duty of the cooler is approximately 87 tons, cooling approximately 160 gpm of 30% ethylene glycol solution from 90°F to 76°F.
- ° Ductwork.--Ductwork at the supply fan will be galvanized steel changing to 6-ft-diameter concrete pipe to go underground to the main shaft. The main shaft will have a supply air compartment

of about 30 sq ft, separated from the rest of the shaft by a concrete partition. In the mine most air flow will be through the mine entries and exhaust tunnels in the salt.

Where ductwork is necessary it will be welded stainless steel, or a noncorrosive material such as fiberglass-reinforced polyester.

- o Exhaust fans.--There will be three mine exhaust fans, each rated at 50,000 cfm at 18" of water, driven by 125-hp electric motors.
- o Exhaust filters.--Each of the three exhaust filter trains will have four stages of filters composed (in order) of 30% and 90% NBS and two stages of HEPA filters. Each bank of filters will be made up of 2-ft by 2-ft filters arranged 5 units high and 7 units wide.

3.6.2.5 Design Alternate Calculations.--Calculations and equipment sizing for the BSPP mine ventilation as described in paragraph 3.6.2.3 and 3.6.2.4 were based on a mine layout for total storage capacity of 400 waste canisters. Since the mine HVAC conceptual design was done, the requirements for the BSPP has been increased to 1000 canisters. It is still planned to have only 5 waste storage rooms ventilated simultaneously, but the greater number of rooms will require longer mine entries and exhaust tunnels. The volume of mine ventilation air may not be changed as a result, but the heating and cooling requirements, and the pressure losses due to friction will change. The design calculations for the mine system must be redone based on the revised conceptual mine plan for the greater number of storage rooms.

3.6.3 Other HVAC Systems

3.6.3.1 Mine Operations and Administration Building System.--Air conditioning will be provided for all areas of the building except toilets. Through-wall-mounted air conditioning units with electric heating coils will be used where possible. Rooms not having exterior walls will have roof-mounted heating-cooling units. Electric heaters will be provided for the toilets. Exhaust fans will provide six air changes per hour for the toilets and the lunch-conference room.

3.6.3.2 Staging Building and Hoist House Systems.--The staging building and main shaft hoist house will be heated in winter and ventilated in summer. Unit heaters will be installed in each room, supplied with hot water from the mine air supply heating boiler. This boiler will be located in the staging building.

3.6.3.3 Warehouse System.--Winter heating will be provided by gas-fired unit heaters. Ventilation will be created through open doors and by roof-mounted ventilators with automatic dampers.

3.6.3.4 Gatehouse Systems.--The gatehouse will be heated with gas heaters and cooled with window-type air conditioning units.

3.7 Electrical System

(Ref. dwg. E-11362-ED-030-E)

3.7.1 Concept-Related Design Requirements and Design Assumptions

The concept of the BSPP, as well as an operating repository, has an inherent need for power for normal uses and other more critical needs. Subsection 2.6.2 gives the basic design requirements to fill these needs. Design assumptions or choices made to fulfill these requirements are as follows.

- Normal power will be supplied at one connecting point, with the voltage reduced to the BSPP primary distribution voltage by the electric utility.
- Primary distribution voltage will be 4.16 kV.
- Motors rated at 150 hp and larger will be supplied directly at primary distribution voltage. Motors rated less than 150 hp and greater than 1/3 hp will generally be supplied at 480 V, 3 ϕ .
- Lighting voltages will be 120/208 volt and 480/277 volt 3 ϕ .
- Standby power generation will be at the primary distribution voltage of 4.16 kV. The source of standby power will be two 1250-kW diesel-driven generators, either of which is sufficient to supply the standby power load demand.
- The uninterrupted power supply will be a dc battery system maintained continuously in a fully charged condition.

3.7.2 Physical Description of System

A detailed estimate of electrical power requirements of the BSPP is provided in Appendix 11.4.

3.7.2.1 Distribution System.--At the pilot plant substation, incoming power will be reduced from the utility transmission voltage to the pilot plant primary distribution voltage of 4.16 kV. At the substation a fused switch and an air circuit breaker will be installed in the pilot plant 4.16 kV feeder to protect against current surges and voltage swings. The BSPP feeder will supply power to an assembly of switchgear having 5 kV air circuit breakers and located in the electrical equipment room in the waste receiving building basement. Power centers, transformers, and high voltage motor starters for large motors located throughout the pilot plant will be supplied from this 4.16 kV switchgear. Specifically, 4.16 kV power will be supplied to:

- o The waste shaft hoist motor;
- o The main shaft hoist motor;
- o The mine substation;
- o The central filter station substation;
- o Transformers for the waste receiving building, located in the electrical equipment room;
- o A transformer located at the main shaft staging building, which will supply power to the staging building, the mine operations and administration building, the warehouse, and the gatehouse.

The power centers supplied with 4.16 kV power will contain high voltage air-break disconnect switches, askarel-filled type transformers for 4.16 kV/480 V, and an assembly of 480-volt breakers and motor starters. Lighting transformers will be 208Y/120-volt for incandescent lighting and 480Y/277-volt for fluorescent.

High-voltage cable from the pilot plant substation to the 4.16 kV switchgear and from the switchgear to the power centers, transformers and motor starters will be run in rigid conduit. Outside of the buildings the conduit will be in underground duct runs of rigid steel or non-metallic conduit encased in red-colored concrete. Manholes will be provided to facilitate cable installation. Mine power cables will be insulated cables installed exposed in the utility compartment of the main shaft. A combination of wire in conduit and cable in trays will be used for distributing low-voltage power within surface buildings of the pilot plant. Power cables will be isolated from control cables. Design of cable installations will include means for preventing propagation of fires in multi-cable applications.

3.7.2.2 Standby Power System.--Two standby power generating units will be provided to supply those loads necessary to maintain the facility in a safe shutdown condition during normal power outage or sustained undervoltage.

The generators will each be rated for 1250 kW at an 0.8 power factor and will have a three-phase output voltage of 4.16 kV. They will be equipped with suitable voltage regulating and adjusting equipment to permit the starting and operation of the standby system loads. Switchgear will be provided to start the standby power units automatically and to isolate the designated loads for operation on this source of power. The generators will be supplied with at least the following accessory equipment:

- Direct-driven exciter
- High-speed voltage regulator
- Exciter field rheostat
- AC voltmeter with transfer switch
- AC ammeter with transfer switch

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the building walls will be used for lighting of sidewalks adjacent to the building and building entrances. Incandescent substation lighting will be used in the BSPP substation.

Color-corrected mercury vapor fixtures will be used for interior lighting in the building areas which have high ceilings. Surface-mounted or suspended fluorescent lighting will be used in all other areas of the facility except for exit lights, stairways, janitor's closets and other similar areas, where incandescent lighting will be used. All interior areas that are lighted with mercury fixtures will be provided with an adequate number of incandescent fixtures to permit safe movement of personnel when the mercury lights are not functioning, such as during the required restarting period immediately following a power outage. In addition, emergency lighting will be provided to permit safe movement of personnel in the building during complete power outages. These lights will normally operate from dc battery power system and will provide nominal illumination upon loss of all other sources of power. In the mine support areas, illumination during power outage will be provided by portable continuously charged dc lights located for maximum lighting effect.

Lighting levels within the pilot plant will be as listed in Table 3.4, which follows the recommendations of the I.E.S. Handbook. Supplemental lighting will be provided in areas where high lighting intensity is required.

No perimeter fence lighting will be provided except at the main entrance gate. The illumination level at the gate will be approximately 5 footcandles. Lighting level at the parking lot will be approximately 2 footcandles.

TABLE 3.4
LIGHTING LEVELS

<u>Room or Area</u>	<u>Footcandles</u> (At floor level unless noted)
<u>Receiving Building:</u>	
Cask unloading area	30
Rail car holding area	30
Transfer cell	50 On viewing side of windows
Transfer gallery	50
Operating gallery	0-60 Adjustable on viewing side of windows
Cage loading compartment	50
Waste concentration room	30
Waste casting room	30
Mechanical equipment room	20
Exhaust fan-filter house	20
Waste shaft hoist house control room	70
Waste shaft hoist house machine room	30
Chemistry laboratory	100 At table height
Personnel check station	70 At table height
Counting room	100 At table height
Office	70 At table height
Change room	25
Maintenance and storage room	50
Electrical equipment room	20
Diesel generator rooms	20
Central control and monitor room	70 At table height
Decontamination equipment room	30
Tank pit	10
Battery room	20
Sheave house	20
Rail car air lock	10
Corridors	20
Stairs	30
<u>Mine Operations and Administration Building:</u>	
Offices	70 At table height
Corridors	20
Change room and toilets	25
Laboratory	100 At table height
<u>Staging Building:</u>	
Hoist control room	70
Lamp repair room	70
Lamp storage room	20
Receiving and storage room	20
Covered dock	20
Cage loading area	30

<u>Room or Area</u>	<u>Footcandles</u> <u>(At floor level unless noted)</u>
<u>Main Shaft Hoist House:</u>	
Control room	70
Machine room	30
<u>Mine Air Supply Fan House</u>	20
<u>Warehouse</u>	20
<u>Central Filter Station</u>	20
<u>Gatehouse</u>	30
<u>Mine Areas:</u>	
Receiving station cell	50 on viewing side of windows
Receiving station operating gallery	0-60 Adjustable
Man and materials station	20
Support areas	20
Transporter loading area	20
Entries and waste storage rooms	2

Obstruction lighting will be provided, if required, for the surface structures in accordance with the Federal Aviation Regulations.

3.7.2.5 Receptacles.--Standard NEMA grounding type receptacles shall be provided, sized at 15 ampere for 120 volt service, 20 ampere for 208 volt, and 60 ampere, 3 phase, for 480 volt service.

Receiving Building:

- a. A minimum of one 120-volt duplex receptacle will be provided on each wall of all areas except janitor's closets; at least two will be located at each viewing window on the transfer cell face;
- b. 208 Volt duplex receptacles will be provided in the following areas:
 - o Cask unloading area (4)
 - o Transfer cell (2)
 - o Transfer gallery (2)
 - o Operating gallery (2)
 - o Cage loading compartment (2)
 - o Waste concentration room
 - o Waste casting room
 - o Mechanical equipment room (2)
 - o Exhaust fan-filter house (2)
 - o Waste shaft hoist house
 - o Chemistry laboratory
 - o Counting room
 - o Maintenance and storage room
 - o Electrical equipment room (2)
 - o Diesel generator rooms

- o Decontamination equipment room
 - o Battery room
 - o Sheave house
- c. Three-phase 480-volt receptacles will be provided in the following areas:
- o Cask unloading area
 - o Transfer cell
 - o Transfer gallery
 - o Cage loading compartment
 - o Waste concentration room
 - o Mechanical equipment room
 - o Exhaust fan-filter house
 - o Waste shaft hoist house
 - o Maintenance and storage room
 - o Electrical equipment room
 - o Diesel generator rooms
- d. The counting room will be served by a metal strip wireway around the periphery of the room above table level, containing 120-volt receptacles on 30-in. centers..

Mine Operations and Administration Building:

- a. A minimum of one 120-volt duplex receptacle will be provided on each wall of all areas except janitor's closets;
- b. One 208-volt duplex receptacle will be provided in the laboratory.

Staging Building:

- a. A minimum of one 120-volt duplex receptacle will be provided on each wall of all areas, including the covered dock and the cage loading area;
- b. One 208-volt duplex receptacle will be provided in the lamp repair room, the hoist control room, the covered dock and the cage loading area; and
- c. One 480-volt, 3-phase receptacle will be provided at the cage loading area.

Man and Materials Hoist House:

120-volt duplex receptacles will be provided on each wall, and one 208-volt duplex and one 480-volt, 3-phase receptacle will be provided in the machine room.

Warehouse:

120- and 208-volt duplex receptacles will be located on each wall, and one 480-volt, 3-phase receptacle will be provided.

Central Filter Station:

- a. 120-volt duplex receptacles will be provided on each wall of the fan room and in each of the three filter train compartments; and
- b. One 208-volt duplex and one 480-volt, 3-phase receptacle will be provided in the fan room.

Mine Air Supply Fan House:

120-volt duplex receptacles will be provided on each wall, and one 480-volt, 3-phase receptacle will be provided.

Gatehouse:

120-volt duplex receptacles will be located on each wall, and one 208-volt duplex receptacle will be provided.

Mine Areas:

120-volt duplex [along with one each 208-volt duplex and 480-volt, 3-phase] receptacles will be provided in these areas:

- Receiving station cell (2)
- Receiving station operating gallery (2)
- Man and materials station
- Support areas

3.7.2.6 Instrument Power.--Instrument power at the pilot plant will be 120-volt supplied from the 480-volt system through regulated dry-type transformers.

3.7.2.7 Communication and Alarms.--A complete system of raceways, outlets, pull boxes, etc., with radial speaker distribution for evacuation and communication will be provided. Wire, cables, instruments, speakers, etc., will be installed by the local telephone company.

A fire alarm system of the positive, non-interfering, succession type will be installed. This system shall be designed in accordance with NFPA Pamphlet No. 72 "Proprietary Signaling Systems."

The communication and alarm systems will be powered from the uninterrupted system.

3.7.2.8 Wiring Methods and Materials.--In general, power wiring within the facility will be in conduit; however, cable trays will be used where required for flexibility. Aluminum or galvanized steel conduit will be used. Non-metallic conduit for underground or embedded runs will be used where economically justified.

Wire for all systems 600 V or less will be copper or aluminum with moisture-and heat-resistant insulation of a thickness as recommended by IPCEA, except for areas where extreme temperatures require a special wire type. A 5 kW wire for 4.16 kV distribution will be a shielded type with rubber insulation. Control cables within the facility will be carried either in cable trays or conduit. The trays will connect all areas where dictated by economy or required for flexibility. Control cables will be run in conduit where cable trays are not practical.

Control cable conductors will be copper and will not be smaller than No. 14 AWG. The cables will be rated for 600 V service and will have an insulation thickness as recommended by IPCEA for the type of insulation used. The conductors of the cable will be covered with a suitable jacket and will be shielded where required by service conditions.

Lighting wiring within the facility will be copper wire in conduit. Conduit for lighting will be either galvanized steel, aluminum or steel electrical metallic tubing. The wire for the lighting system will have moisture-resistant, or heat- and moisture-resistant insulation.

All lighting fixtures, switches, receptacles, and other items of electrical materials and equipment will be approved by the Underwriters Laboratories, Inc., where applicable.

3.7.2.9 Grounding System.--Grid-type ground systems will be installed for the BSPP. These grids will consist of a loop of stranded annealed copper wire at least 4/0 AWG completely encircling a building or area, together with a number of cross connections between two points on the loop. Copper-clad steel ground rods at least 10 ft long will be driven at each corner of the ground loop and at enough intermediate points to obtain a resistance from each grid to earth of not more than 5 ohms as measured by the "fall of potential" method.

The following items will be connected directly to the ground grid:

- o Alternate outside columns of steel-framed buildings and not less than one-third of all the inside columns of the buildings.
- o All metal non-current-carrying parts of motors and major electrical equipment.
- o The secondary neutral resistor of the substation transformer.
- o Ground buses of switchgear and motor control centers.

3.8 Site Improvements, Utilities and Services

3.8.1 Design Assumptions

- a. Water System.--It has been assumed, for purposes of this conceptual design, that an adequate supply of suitable water is available underground at the proposed site. Subsequent hydrological studies indicate that water in quantities required for BSPP operation may not be available underground. Additional studies shall be made during Title I design to determine a dependable source of water for the facility.
- b. Fuel System.--As noted in paragraph 2.7.2.2, it shall be assumed that fuel gas is available in adequate supply to provide the process and facility heating requirements for the facility. This assumption also shall be evaluated during Title I design.

3.8.2 Physical Description

3.8.2.1 Improvements to Land (Ref. dwg-C-102-3)

- a. Site Clearing, Grading and Landscaping.--A minimum of site clearing will be required. Areas designated for buildings, roads, railroads, other structures and structural or nonstructural fills will be stripped of growth and topsoil. Areas not affected by construction activity will be left in their natural state.

There will be a minimum of site grading required because of the relatively low relief in the site area. Areas requiring structural fill to bring them to grade will be cleared and stripped, the subgrade compacted, and the fill material placed and compacted. Nonstructural

fill areas will be cleared and fill material will be spread in thin lifts. Grading for site drainage will be on the basis of overland sheet flow collected in open ditches and drainage swales. The drainage ditches and swales will carry the collected storm water discharge to the nearest natural drainage channel. Culverts will be provided to pass storm drainage under roads and railroads. Efforts will be directed toward minimizing erosion during and after construction.

Landscaping will be limited to the restoration of ground cover in those areas disturbed during the construction operation. The ground cover used will consist of local grasses to provide adequate protection against erosion.

b. Roads and Parking.--Primary roads will serve the waste receiving building, the warehouse and the main parking lot. Primary roads will have two 12-ft-wide lanes with 6-in-wide shoulders. Pending design analysis based on field and laboratory soil tests, the primary road section has been assumed to be 1-1/2 in. of asphaltic concrete over 8 in. of compacted aggregate subbase. This pavement section will be founded on not less than 6 in. of compacted subgrade made from suitable native material. The shoulders will consist of 6 in. of compacted aggregate base course material on compacted subgrade with a single bituminous surface treatment. Drainage slopes of 2% for the traveled way and 5% for the shoulders will be used.

Secondary roads will serve the mine exhaust shaft and central filter station, the staging building, the sewage treatment plant, the man and materials hoist house and the mine operations and administration building. Secondary roads will be a single 12-ft-wide lane with 4-ft-wide shoulders. Pending design analysis based on field and laboratory soil tests, the secondary road section has been assumed to be a double bituminous surface treatment on 8 in. of compacted aggregate base course material, founded on 6 in. of compacted native material. Shoulders will have 6 in. of aggregate base material on compacted subgrade. Drainage slopes of 2% and 5% will be provided for the traveled way and shoulders respectively.

A facility parking lot, with space for approximately 44 vehicles, will be provided outside the entrance gate for the BSPP staff, visitors, and shift personnel. In addition, a 10-car lot will be provided at the mine operations and administration building for official vehicles. Access aprons and turn-around areas will be provided as shown on plot plan dwg. C-102-3. All parking lots and aprons will be of the same structural section as the secondary roads. Drainage of parking lots and aprons will be by sheet flow to surface drainage ditches or swales.

Sidewalks will be provided as shown on dwg. C-102-3. The sidewalks will be concrete 4 in. thick, 4 ft wide. They will be founded on 2 in. of compacted granular material on compacted subgrade.

c. Fencing. Fencing design criteria, including the requirement to fence

around BSPP structures, are given in paragraph 2.7.2.1. The primary fenced area will include all the surface structures except the central filter station, the electrical substation, and the main parking lot. Separate perimeter fences will be provided around the central filter station and the substation, while the main parking lot will be outside the fenced area near the main entrance. Swing-type vehicular gates will be provided in the perimeter fence at the main road entrance and the railroad entrances. They will also be provided in the localized fencing enclosing the central filter station and the substation.

All fencing will be grounded in accordance with OR Appendix 6301. Fence installations which cross "power corridors" will be further grounded in accordance with that same document.

Man barriers will be provided at points where the perimeter fence crosses the surface drainage system ditches.

d. Relocation of Utilities.--Privately owned gas and oil transmission lines may cross the BSPP site. Only those lines will be relocated which interfere with construction or represent a potential hazard during operation of the facility. To preclude potential hazards, all gas or oil transmission lines will be relocated to provide at least 500 ft clearance from all surface structures.

3.8.2.2 Utilities (Ref. dwg. P-101-3).--The design requirements and assumptions for the BSPP utilities are set forth in paragraphs 2.7.2.2 and 3.8.1. Brief description of the conceptual design of the utility systems follows:

a. Railroads.--A standard-gage railroad spur will provide service to the BSPP from the nearest accessible commercial spur. Sidings and working track will provide space for handling five full and five empty rail cars at the waste receiving building. The track structural section will consist of 18 in. of ballast on a compacted subgrade, 7-in. by 9-in. by 8 ft- 6 in.-timber ties and 90-pound A.R.A rail. Bumping posts will be provided at exterior dead end track locations.

In-plant rail car movements will be handled by a combination highway and railtrack switching vehicle.

Provisions will be made for future through-trackage at the waste receiving building as shown on drawing C-102-3. Provisions will also be made for future installation of trackage for salt removal.

b. Water Systems.--The BSPP domestic and fire protection water systems will be combined in a common supply and distribution system. A looped system will be provided around the main plant area.

(1) Domestic Water. --BSPP domestic water system will be comprised of an 8-inch-diameter pipe loop with separate laterals to each of the following major facilities and buildings:

- o Mine operations and administration building
- o Waste receiving building
- o Mine air supply fan house
- o Warehouse
- o Gatehouse
- o Staging building

Cast iron pipe with 3 ft of earth cover for freeze protection will be used for the domestic supply and distribution system.

Potable water for mine use will be supplied in portable containers.

(2) Fire Protection Water.--The fire protection water system will provide a water supply for sprinkler systems, hose racks and fire hydrants. Separate fire protection laterals will be provided from the common water supply loop to serve all the surface buildings and facilities. The system will have the following design features.

- o 140,000-gal elevated storage tank, with bottom of tank 140 ft above grade, providing two-hour fire flow.
- o Hydrants will be 500-gpm capacity dry barrel type with two 2-1/2-in. outlets. A single pumper outlet will be provided. Pumper outlet size will conform to local fire department requirements.
- o Hydrants will be placed no farther than 500 ft apart and not farther than 250 ft from the building served.
- o Residual pressure at hydrants will be 60 psig with a flow of 500 gpm.
- o Hydrant laterals will be not less than 6-in. diameter. Each lateral will be provided with an isolation valve.
- o Hydrants located in areas that may make them susceptible to damage from vehicular traffic will be protected by suitable guard posts.

- o Sprinkler laterals will be not less than 6-in. diameter.

Post indicator valves will be provided as required.

- o Minimum residual pressure at the highest sprinkler will be 15 psig.
- o Dual supply pumps, complete with automatic controllers, will be provided at the storage tank. The pump suctions and discharges will be connected in parallel. The suction will be supplied by the well pump discharge header; the pumps will discharge to the elevated storage tank. The pumps will be supplied with normal and standby power. Automatic alternators will be provided to distribute operational use.

(3) Process Water System.--Process water will be supplied to process equipment, boiler feed systems, air conditioning systems, laboratory hoods and benches, hose connections, and other connections where contamination of the domestic water system is possible through reversal of flow. The process water system will be supplied from the domestic water supply system through an air gap or an approved reduced-pressure-principal backflow preventer to preclude contamination of the potable water system. To the maximum extent possible, the process water requirements for the facility will be supplied from the decontaminated distillate from the evaporation of site-generated liquid waste, thus minimizing the BSPP water supply requirements.

c. Fuel System.--Natural gas will be used as the primary heating fuel for building and mine space heating, domestic water heaters, and the waste concentration system boiler. It was assumed that natural gas will be the most economical and readily available fuel. Further investigation will be required during Title I design to confirm or revise this assumption. The system will have a design capacity of 9750 cfh.

Gas from a commercial source will flow through a pressure reducing valve, a connecting supply line, a meter, and then into the BSPP distribution system. The distribution system will convey the gas to the various buildings at 15 psig. The gas pressure will be reduced further at the buildings as required to meet operating requirements.

The main connecting to the supply source will consist of 3-in. diameter steel pipe with extruded PVC outer jacket. Pressure reducing valves will be provided at each of the buildings to reduce the pressures to approximately 1/4 psig as required by the equipment served.

Relief valves will be provided as required to prevent over-pressuring of the distribution system. Guard posts will be provided around all above-ground parts of the system. Isolation valves, identified by marker posts, will be provided so that the system components can be isolated for repair, maintenance, or modification.

Fuel oil will be used as a backup for the heating system, as well as the prime fuel source for the standby electric generators.

d. Sanitary Waste Disposal System.--The sanitary waste system consists of a collection system and a packaged sewage treatment unit. The collection system will consist of a piping network, serving the sanitary facilities of all surface buildings, which will discharge by gravity to the sewage treatment plant. Precast manholes will be used for collection and flow direction. The sewage treatment plant will be a package unit with a 3000 gpd capacity. It shall provide the equivalent of primary and secondary treatment giving a 90% reduction in 5-day B.O.D. Provisions will be made for physical transfer of sanitary waste generated in the mine into the surface collection system.

e. Site-Generated Waste System (Ref. dwg. P-102-3).--

The process waste system will be located in the waste receiving building. All floor drains from potentially contaminated areas, as well as the drains from the chemistry laboratory, the cask cooling and decontamination equipment, and the mine shaft sump discharge into a confined collection sump from which the waste will be pumped into a process waste collection tank.

Nonprocess wastes which may become contaminated and require processing include effluents from change room showers, hand and janitor sinks, and the fire water system. A 10,000-gal controlled waste collection tank will be provided outside the waste receiving building into which these wastes will be discharged via the controlled drain collection and floor, fire and sink drain systems, respectively.

The contents of the tanks will be sampled at regular intervals and, if contaminated, will be transferred to the process waste collection tank for processing. If free of contamination the contents will be evaporated to the atmosphere by a submerged evaporator.

Prior to processing, the contents of the process waste collection tank will be sampled and the pH adjusted. Batches of the adjusted solution will be evaporated, condensed, collected, and sampled. If satisfactorily decontaminated, the condensate will be pumped through a cation-anion exchange column. After further sampling the demineralized water will be used as process water makeup. Provisions will be made to permit the recycle of evaporator condensate and demineralized water for additional cleanup, if necessary.

The evaporator concentrate, containing the bulk of the radioactive contaminants, will be blended with dry cement and solidified in 55-gal drums. The drums will be lowered to mine level for storage. The equipment for processing the evaporator concentrate into a solidified form remains to be developed.

Principal equipment components for the system include:

- o A 10,000-gal controlled waste collection tank, located in a concrete pit at the waste receiving building, and a boil-off evaporator.
- o A process waste collection tank with an operating capacity of 3000 gal. The tank will be of stainless steel, equipped with an air sparge line, pressure and liquid level recording instrumentation, sampler, steam-operated decontamination jet and a vent equipped with a HEPA filter.

- o A 100-gal open-top solution makeup tank, located in the maintenance and storage room, to be used to make up caustic for neutralizing the contents of the process waste collection tank.
- o A batch waste evaporator of stainless steel construction, with an operating capacity of 500 gal. The evaporator will be steam heated and will be designed for a boilup rate of approximately 680 lb/hr. The evaporator will have a demister and appropriate instrumentation for monitoring and recording pressure, temperature, liquid level, and density.
- o An evaporator condenser of stainless steel construction, designed to condense 680 lb of vapor per hour and to subcool the condensate.
- o An off-gas heater to remove any water vapor from the gases leaving the evaporator before discharge to the vent stack.
- o A condensate collection tank with an operating capacity of approximately 3000 gal. The tank will be equipped with a sampler, vent with a HEPA filter, and process instrumentation to monitor temperature and liquid level.
- o Waste casting equipment, which remains to be developed, to solidify the evaporator concentrates in concrete.

- o A cooler to reduce the temperature of the evaporator concentrate prior to mixing with cement in the waste casting step.
- o Cation-anion exchange columns, designed for a flow of 5 gpm each. Replaceable ion exchange cartridges will be used. The columns will contain instrumentation for monitoring differential pressure and flow.
- o A stainless steel demineralized water tank with an operating capacity of 3000 gal and equipped with a vent, sampler, and instrumentation for monitoring liquid level.
- o Canned rotor type transfer pumps.
- o Diaphragm type metering pumps.
- o Samplers on the process waste collection tank, condensate collection tank, and the demineralized water tank will be locally mounted and will consist of a recirculating pump loop, containing a valved sample draw-off nozzle.

The waste system will be designed to preclude accidental discharge of radioactive liquids to the environment, and the process will be carefully instrumented to ensure safe operation. Alarms will be installed on processing equipment to indicate sources of malfunction. The equipment will be installed in an area designed for Category I tornado and seismic resistance and will be arranged to permit the addition of unit shielding as required.

3.8.2.3 Services

a. Location.--Services will be provided to locations shown in Table

3.5. Connections will be made to machines and equipment requiring piped services. In addition, valved outlets with hose coupling connections will be provided for compressed air and process water in areas where the table shows these services are needed.

b. Materials and Construction.--Materials tentatively selected to be used in the piping systems are described in the following schedule. Subject to further investigation during Title I engineering of such things as local soil conditions, the schedule appropriate to each system will be as listed in Table 3.6.

Schedule A: AWWA approved cast iron pressure pipe and fittings with mechanical joints and neoprene gaskets.

Schedule B: Sizes 3 in. and larger--black steel pipe with butt weld fittings and joints; smaller than 3 in.--galvanized steel pipe and screwod, galvanized, malleable iron fittings; all sizes in underground service to have bitumastic waterproof coating.

Schedule C: Seamless black steel pipe with extruded PVC cover; 3 in. and larger--butt weld fittings and joints; smaller than 3-in.--socket weld; wrap all joints with vinyl tape.

Schedule D: Pipe 3/4 in. and larger--black steel with socket weld joints and fittings; smaller than 3/4 in.--copper tubing with compression type fittings.

TABLE 3.5
SERVICE REQUIREMENTS

Room or Area	Fire Protection	Water		Process	Serv.	Comp. Air Instr.	Fuel Gas	Fuel Oil	Waste			Process Steam
		Hot	Cold						San.	Process	Controlled	
Receiving Building:												
Cask Unloading Area	X		X	X	X				X	X	X	
Rail Car Holding Area	X				X						X	
Transfer Cell					X	X						
Transfer Gallery	X			X	X	X				X	X	
Operating Gallery	X		X			X			X		X	
Cage Loading Compart.					X							
Waste Concent. Room	X			X	X	X				X		X
Waste Casting Room	X			X	X	X				X		
Mech. Equipment Room	X			X	X		X	X	X		X	
Exhaust Fan-Filter House	X				X	X					X	
Waste Hoist House Control Room	X		X						X		X	
Waste Hoist House Machine Room	X				X						X	
Chemistry Lab	X			X	X		X				X	
Personnel Check Sta.	X										X	
Counting Room	X					X					X	
Office	X											
Change Room	X	X	X						X		X	
Corridors	X										X	
Maintenance and Storage Room	X				X						X	
Elect. Equipment Room	X				X				X			
Diesel Generator Rooms	X				X			X	X			
Central Control and Monitor Room	X		X			X			X			
Decontamination Equipment Room	X			X	X	X				X		X
Tank Pit						X				X		
Battery Room	X			X							X	
Sheave House												
Rail Car Air Lock	X										X	

TABLE 3.5 (Cont.)

Room or Area	Fire Protection	Water		Process	Comp. Air Serv.	Instr.	Fuel Gas	Fuel Oil	Waste			Process Steam
		Hot	Potable Cold						San.	Process	Controlled	
Mine Operations and Administration Building:												
Corridors	X											
Offices	X											
Change Room	X	X	X						X		X	
Toilets	X	X	X						X			
Laboratory	X			X		X	X				X	
Staging Building:												
Hoist Control Room	X		X			X			X			
Lamp Repair Room	X				X							
Lamp Storage Room	X											
Receiving and Stor- age Room	X				X		X	X				
Covered Dock	X				X							
Cage Loading Area	X				X							
Man and Materials Hoist House:												
Control Room	X		X		X				X			
Machine Room	X				X							
Warehouse	X		X		X		X		X			
Central Filter Station	Note 1				X							
Gatehouse	X		X				X		X			
Mine Air Supply Fan House	X				X	X			X			

Note 1: Fire Protection sprinklers in fan room only.

TABLE 3.6
SCHEDULE OF PIPE MATERIALS

System	Underground Service	Aboveground Service
Filtered Water	A	J
Fire Protection Water	A	H
Process Water	A	J
Compressed Air	B	B
Fuel Gas	C	K
Fuel Oil	D	D
Sanitary Waste	E	L
Process Waste	F	M
Controlled Waste	F	M
Steam	G	N

Schedule E: Concrete sewer tile with bell joints caulked with portland cement.

Schedule F: Vitrified clay tile with bell joints caulked with acid resistant cement.

Schedule G: Pipe 3 in. and larger--black steel with butt weld joints and fittings; smaller than 3 in.--socket weld; insulate with granulated hydrocarbon backfill insulation.

Schedule H: Steel pipe and cast iron fittings meeting the requirements of N.F.P.A. 13.

Schedule J: Pipe 4 in. and larger--black steel with butt weld fittings and joints; 3 in. and smaller--galvanized steel pipe and screwed, galvanized, malleable iron fittings; insulate hot water with molded fiberglass insulation.

Schedule K: Black, seamless steel pipe; 3 in. and larger--butt weld joints and fittings; smaller--socket weld. Small lines such as laboratory services may be seamless copper with silver soldered joints and fittings.

Schedule L: All concrete imbedded lines and sizes 4 in. and larger--extra heavy cast iron soil pipe with lead caulked joints or approved neoprene gasket joints; 3 in. and smaller--galvanized steel pipe and cast iron screwed drainage fittings.

Schedule M: Schedule 80 PVC normal impact pipe and PVC socket type drainage fittings with solvent cement joints.

Schedule N: Same as Schedule G but with molded calcium silicate insulation.

3.9 Monitoring and Surveillance

The conceptual design is based on the double confinement philosophy used in other radioactive handling and processing facilities. Canisters, cars, or casks will enter the waste receiving buildings through an air lock. Ventilation air from all areas of potential contamination will be filtered before release and operations will be carried out in areas controlled at negative pressure relative to the outside. Site and regional monitoring systems will be provided to assure that the confinement systems function properly.

3.9.1 Concept-Related Design Requirements and Design Assumptions

3.9.1.1 Site Monitoring.--The current BSPP concept provides two exhaust ventilation stacks. In keeping with the requirements of subsection 2.8.2 these stacks will be continuously monitored and sampled for the detection and recording of radioactive particulates and noxious gases in the BSPP effluents. Gaseous and liquid effluent monitors will be located at the periphery of the exclusion area and within or at the site boundaries.

It is assumed that the mine ventilation stack exhaust is 10 ft above the ground surface and that the waste receiving building stack exhaust is located 10 ft above the building roof level, or approximately 48 ft above the ground surface. It is also assumed that the wind rose for the Carlsbad area (shown in Fig. 3.8) and the data upon which it was based (Table 3.7) are applicable to the BSPP study area.

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Fig 3.8 Annual Wind Rose

TABLE 3.7

WIND SUMMARY, CARLSBAD, NEW MEXICO

NUMBER OF OBSERVATIONS BY DIRECTION AND VELOCITY (Period of record July 1, 1950 - Dec. 31, 1954)									
MILES PER HOUR									
DIR:	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47+
N	170	556	546	246	146	48	7		
NNE	261	831	989	406	148	38	15	3	1
NE	156	360	333	75	30	5			1
ENE	113	357	405	97	33	2	3	2	
E	109	359	381	80	11	4			
ESE	147	568	1015	441	143	19	5	1	1
SE	145	621	1377	727	284	40	9		
SSE	167	803	2314	1767	765	114	14	3	
S	147	579	1393	622	181	37	8	4	2
SSW	125	559	1193	553	208	72	26	8	6
SW	131	429	709	289	149	112	44	9	5
WSW	112	413	857	761	763	793	471	252	129
W	117	340	597	332	217	201	120	63	49
WNW	125	384	642	336	167	87	42	8	5
NW	141	303	427	177	74	16	9	4	
NNW	196	612	916	634	330	110	19	5	2
CALM	696								
TOT:	3058	8074	14094	7543	3649	1707	792	362	201

3.9.1.2 Facility Radiation Monitoring.--In keeping with the requirements of subsection 2.8.2, the following areas will be monitored and surveyed to indicate airborne activity, penetrating radiation, and contaminated personnel or materiel:

o Area Monitoring

Waste receiving building:

Cask unloading area

Transfer gallery

Transfer cell operating gallery

Waste casting room

Support area corridor

Decontamination equipment and cage service room

Exhaust fan - filter house

Waste hoist house

Staging building:

Staging area

Main shaft hoist house

Mine level:

Mine-level receiving station operating gallery

Main shaft air lock

Waste storage room main entry

Escape shaft entry

o Personnel/Materiel Monitoring.

Waste receiving building:

Personnel check station

Equipment air lock

Cask unloading area

Maintenance and storage air lock

Staging building:

Staging area

Mine area:

Main shaft air lock

3.9.2 Physical Description

3.9.2.1 Site Monitoring.--Multiple samplers and instrumentation will be provided to continuously monitor, indicate, and record the level of radioactivity in effluents discharged from confinement areas. The system will consist of in-stack samplers, alpha and beta-gamma monitors, inert gas monitors and gas flow measurement equipment which will provide data on the quality of air being discharged to the environment from both the mine exhaust stack and the waste receiving building exhaust stack. The data thus collected will be indicated locally at the stacks and recorded at the central control and alarm station. Alarms will be employed to give audible evidence of any abnormal readings.

Perimeter air and fallout monitors will be installed at a number of points within the BSPP site. Locations will be based on prevailing wind patterns. Figure 3.9 indicates a conceptual location based upon the three predominant wind directions from the Carlsbad area wind rose, viz., south-southeast, west-southwest and north (the latter being a compromise between two predominant wind directions at north-northeast and north-northwest).

Surface storm water drainage will be monitored at appropriate locations where the drainage leaves the site. A continuous recirculating sampler and monitor-alarm system will be installed in manholes at these locations.

3.9.2.2 Facility Radiation Monitoring.--It is the intent of the design that all materiel and personnel entering or leaving facilities having contamination potential do so through specified routes and that each route be equipped to monitor departing materiel or personnel for contamination. Means of detection will include portable GM survey meters, portable ion chamber survey meters, fixed laboratory monitors with beta and gamma probes, and fixed hand and foot counters. These monitoring instruments will be located at appropriate departure routes and other control points as noted on Figs. 3.10 through 3.12.

In addition, airborne activity levels will be monitored in all areas of potential contamination. Means of detection will include portable air samplers (for non-routine operations) and fixed beta-gamma air monitors. Locations proposed for the fixed instrumentation are also shown on Figs. 3.10 through 3.12.

Fig 3.9 TENTATIVE LOCATION - BSPP SITE MONITERS

Fig. 3.10
TENTATIVE LOCATION OF MONITORS
GROUND FLOOR-WASTE REC'G BLDG.

- ▲ PERSONNEL/EQUIPMENT MONITORS
- * AREA MONITORS
- A.L. AIR LOCK

Fig. 3.11
TENTATIVE LOCATION OF MONITORS
BASEMENT FLOOR-WASTE REC'G BLDG.

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Fig. 3.12 Tentative Location of Monitors -
Mine Level-Bedded Salt Pilot Plant

3.9.2.3 Confinement and Safety System Monitoring.--All recording and alarm instruments will be located on one or more panel boards at the central control and monitor station in the waste receiving building. Therefore, all pertinent data will be assembled at one location, and all instrumentation and control systems affecting the confinement and safety of the pilot plant will be under the scrutiny of a single operator. Included will be the stack monitoring and stack flow system instruments and the surface storm water drainage monitoring instruments and alarms described in 3.9.2.1 above; airborne activity level monitoring instruments and alarms described in 3.9.2.2 above; the confinement zone pressure and air flow regulating, indicating, and recording instrumentation and alarms; and instruments and alarms which indicate the functioning or malfunctioning of equipment items which affect the maintaining of adequate confinement.

The most important alarms for all systems will be duplicated at an alarm panel located at the gatehouse, thus enabling continuous surveillance of these systems by security guards during off-shift hours.

3.10 Miscellaneous Equipment

In addition to the equipment used for handling and emplacement of solidified wastes and for the concentration and solidification of site-generated wastes, standard types of equipment will be required for support and maintenance facilities. These equipment types and pieces are listed below.

3.10.1 Waste Receiving Building

<u>Item</u>	<u>Quantity</u>
<u>General</u>	
Desk and chair sets	7
File cabinets	3
Book cases	2
Coat racks	3
Fire extinguishers (1 in hoist house)	7
Janitorial equipment storage locker	1
<u>Counting Room</u>	
Work tables	5
Storage cabinets	2
Calculating machine	1
Waste cans	4
High intensity lights	4
<u>Personnel Check Station</u>	
Table	1
Storage cabinets	6
File cabinet	1

<u>Item</u>	<u>Quantity</u>
<u>Change Room</u>	
Lockers	21
Benches	2
Toilet room accessories (paper towel cabinet, mirrors, shelves, clothes hamper, etc.)	1 lot
<u>Chemistry Laboratory</u>	
Combination wall table and fume hood	1
Combination service and utility table	1
Storage cabinet	1
Balance table	1
Laboratory bench w/services	1
Chemists desks and chair sets	2
<u>Central Control and Monitor Room</u>	
Work bench	1
Cabinet tool storage	1
Desk and chair sets	2
<u>Maintenance and Storage Room</u>	
Maintenance work benches	2
Tool storage cabinet	1
Maintenance supply storage cabinet	1
Chain hoist, manual	1

3.10.2 Mine Operations and Administration Building

<u>Item</u>	<u>Quantity</u>
<u>General</u>	
Desk and chair sets	15
File cabinets	10
Typewriters	4
Calculating machines	3
Bookcases	15
Coat racks	4
Safe	1
Supply storage cabinets	2
Fire extinguishers (Class A)	3
Time clock and card storage	1
Janitorial equipment and storage shelves	2
Toilet room accessories (paper towel cabinet, mirrors, shelves, waste receptacles)	2 sets
<u>Lunch and Conference Room</u>	
Tables	12
Chairs	48
Bulletin board and black board	1 each
<u>Drafting Equipment</u>	
Drafting boards and stools	2 sets
Drafting equipment	2 sets
Reference tables	2
Drawing storage file	1
Blue print machine	1

<u>Item</u>	<u>Quantity</u>
<u>Change Room</u>	
Lockers and baskets	38
Benches	3
Toilet room accessories (paper towel cabinet, mirrors, shelves, waste receptacle, etc.)	1 lot
<u>First Aid Equipment</u>	
Examination table	1
Portable light	1
Autoclave - sterilizer	1
Instrument storage case	1
Waiting chairs and examination stool	2 each
Recording desk	1
Counter with built-in sink	1
Gurney (folding type)	1
<u>Personnel Check Station</u>	
Tables	2
Storage cabinets	6
3.10.3 <u>Warehouse</u>	
Bench vise	1
Welding machine	1
Bench grinder	1
Lathe and drill press	1
Power hacksaw	1
Work benches	3
Desk and chair set	1
Bins and shelving	1 lot
Tool lockers	2

3.10.4 Mine Support Area

<u>Item</u>	<u>Quantity</u>
Electric welders	2
Sets of gas cutting and welding accessories, plus gas stocks	1
Sets of lubrication gear (air operated)	1
Heavy duty bench grinder	1
Dank saw	1
Hydraulic press	1
Mechanics' drill press	1
3-ton electric jib cranes	2
40 cfm compressor with air receiver (20 ft ³) plus air lines	1
Hydraulic jacks (1-5 ton)	10
Benches, vises and lockers	1 lot
Cleaning tank, 6 ft by 4 ft by 5 ft, steel, with gratings and air connections	1
Fire extinguishers	6
First aid cabinet	1
Examination table	1
Gurney (folding type)	1

3.10.5 Staging Building

Record file	1
Storage shelves	6 sets
Small parts equipment bins	4
Work benches	2
Platform truck	1

	<u>Item</u>	<u>Quantity</u>
	Utility hand truck	1
	Chain hoist, manual	1
3.10.6	<u>Gatehouse</u>	
	Desk	1
	Table	1
	Chairs	3
	Filing cabinet	1

REFERENCES

1. USGS-4339-7, Salt Deposits of Los Medaños Area, Eddy and Lea Counties, New Mexico, C. L. Jones, Open-file report (1973)
2. USGS-4339-1, Geology and Hydrology of the Carlsbad Potash Area, Eddy and Lea Counties, New Mexico, Arnold L. Brokaw, et al., Open-file report (1972).

4. SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

4.1 Operating Limitations and Set Points

The limitations and appropriate high and low set points of regulating and controlling instruments and devices will be presented approximately in accordance with the following outline, as the information is developed during Titles I and II engineering. A similar tabulation or listing will be made of operating safety features designed into the systems, including alarms, interlocks, relief valves, overflow provisions, and limit switches.

4.1.1 Waste handling system

- o Capacity
- o Load limitations of handling equipment
- o Thermal limitations

4.1.2 HVAC and confinement system

- o Pressure and pressure differentials
- o Temperature

4.1.3 Electrical system

- o Normal electrical system
- o Standby system
- o Uninterrupted power system
- o Alarm and control systems

4.1.4 Utilities and services

- o Road and railroad capacity and load limitations
- o Water system

4.1.4 Utilities and services (continued)

- o Fuel system
- o Sanitary waste system
- o Site-generated waste processing system
- o Compressed air system

4.1.5 Monitoring and surveillance system

- o Site monitoring
- o Internal radiation monitoring
- o Confinement and safety system monitoring

5. OPERATION

Operating procedures will be written for all applicable systems and subsystems approximately in accordance with the following outline. The procedures will be written as design information is developed during Titles I and II engineering.

5.1 Startup

5.1.1 Waste handling system

- o Cask handling
- o Canister unloading and transfer
- o Emplacement in mine
- o Retrieval

5.1.2 HVAC and confinement systems

- o Confinement systems
 - Primary
 - Secondary
 - Mine

- o HVAC systems

5.1.3 Electrical system

- o General distribution (normal power)
- o Standby power
- o Uninterrupted power
- o Communications
- o Alarms
- o Building and facility electrical

5.1.4 Utilities and services systems

- o Water
- o Fuel
- o Sanitary waste
- o Site-generated waste
- o Compressed air

5.1.5 Monitoring and surveillance system

- o Site monitoring
- o Internal radiation monitoring
- o Confinement and safety system monitoring

5.1.6 Experimental procedures

- o Temperature measurement
- o Gas permeability measurement
- o Brine migration measurement
- o Radiolytic and hydrolytic gas generation measurement
- o Gas transport measurement
- o Rock mechanics measurement
- o Canister integrity monitoring

5.2 Normal Operation

Same outline as 5.1 above.

5.3 Shutdown

Same outline as 5.1 above.

5.4 Emergency Operation

Same outline as 5.1 above, as applicable.

5.5 Decommissioning

5.5.1 Surface Facilities

- o Decontamination
- o Demolition and disposal

5.5.2 Mine and shaft sealing procedures

5.5.3 Perpetual surveillance

6. CASUALTY EVENTS AND RECOVERY PROCEDURES

The discussion of casualty events and recovery procedures will be discussed fully in the preliminary safety analysis report (PSAR). The following is a brief outline of the content of that section of the PSAR.

6.1 Safety Precautions

6.2 Casualty Events

Discuss separately each abnormal system or plant condition which could:

- o affect the safety, integrity, or proper functional operation of the system or plant; or
- o produce system or plant degradation or affect personnel safety; and which requires action to restore the plant or system to normal operating mode or safe condition, or to mitigate the consequences of the casualty event.

6.3 Design Features

Discuss the design features of the plant or system which provide protection and/or mitigate the effects of the casualty events listed in 6.2. Each of these features should be identified with the corresponding casualty event in 6.2.

6.4 Recovery Procedures

Outline the recovery procedures to be performed by operating personnel to restore the plant or system to normal, safe, operating condition or shut-

down following each of the casualty events described in 6.2. Each of these procedures should be identified with the corresponding casualty event in 6.2.

7. MAINTENANCE

Maintenance procedures will be prepared during Title II engineering in accordance with the outline below. Separate procedures will be prepared for each major equipment component or for groups of similar or duplicate equipment components where appropriate.

7.1 Maintenance Approach

- 7.1.1 Equipment in areas of possible contamination
- 7.1.2 Equipment required for waste handling
- 7.1.3 Equipment required for maintaining confinement
- 7.1.4 All other systems

7.2 Corrective Maintenance

- 7.2.1 For each system listed in 7.1.1 list:
 - o Steps needed to isolate for repair
 - o Describe tools or backup equipment needed
 - o Tell how repaired or replaced
- 7.2.2 (ditto 7.2.1 for 7.1.2)
- 7.2.3 (ditto 7.2.1 for 7.1.3)
- 7.2.4 (ditto 7.2.1 for 7.1.4)

7.3 Preventive Maintenance

- 7.3.1 Preventive maintenance philosophy for systems in 7.1.1
- 7.3.2 " " " " " " 7.1.2
- 7.3.3 " " " " " " 7.1.3
- 7.3.4 " " " " " " 7.1.4

7.4 In-Service Inspection

7.4.1 Procedures for inspecting systems in 7.1.1

7.4.2 " " " " " 7.1.2

7.4.3 " " " " " 7.1.3

7.4.4 " " " " " 7.1.4

7.5 Surveillance

7.5.1 Instruments for surveillance of systems in 7.1.1

7.5.2 " " " " " " 7.1.2

7.5.3 " " " " " " 7.1.3

7.5.4 " " " " " " 7.1.4

8. QUALITY ASSURANCE

The scope of the quality assurance program during the conceptual design is described in section 2.5. The quality assurance program will be outlined in this section during Title I engineering.

9. SCHEDULE FOR ENGINEERING AND CONSTRUCTION

The estimated schedule for the design and construction of the BSPP, including the acquisition of land and mineral rights, is shown on Fig. 9.1. It has been assumed that site preparation work will be accomplished by the Government under CPFF or lump-sum contract in advance of the bulk of the construction work and that site acquisition will be initiated as soon as or before capital project funds are available.

The schedule was formulated without consultation with Kaiser Engineers; however, the estimated elapsed times for some of the elements of engineering and construction were taken from Kaiser's work of November 1972.

Fig. 5.1. BSPP Design and Construction Schedule.

10. EXPANSION OF BEDDED SALT PILOT PLANT

After the experience gained from operation of the BSPP verifies the concept of waste disposal in salt, it may be desirable to convert the pilot plant to an operating repository. A brief survey of the BSPP is given in Table 10.1, which indicates the relative ease with which such a conversion can be made.

TABLE 10.1 ADAPTABILITY OF BSPP SYSTEMS TO FULL-SCALE REPOSITORY

System/Facility	System Adequate (1)	System Easily Expandable (2)	System Expandable with Difficulty (3)	Remarks
1. Site and Environs	X			Will withdraw land/mineral rights adequate for full-scale repository.
2. Architectural/structural				
a. Waste receiving bldg., except change room and office space	X			All surface facilities and systems for handling waste will be adequate for full-scale repository handling rate.
Change room/office space		X		Bldg. arranged to permit easy expansion of support space.
b. Waste shaft and hoist house	X			Design will be adequate for full-scale repository.
c. Mine-level receiving station	X			Same as 2.b.
d. Main shaft, hoist house, staging bldg.	X			Probably adequate for men and materials. Another mine ventilation air supply shaft might be required for full-scale repository.
e. Mine exhaust shaft		X		Will probably need one or more additional exhaust shafts for full-scale repository, located near repository limits.
f. Mine escape shaft		X		Same as 2.e.
g. Mine operations and admin. bldg.		X		Can expand bldg. easily or build additional, if required.
h. Warehouse		X		Same as 2.g.
i. Gatehouse	X			
3. Mine Development				
a. Mine		X		Purchase mining and salt handling equipment.
b. Mine support areas	X			
c. Salt removal facilities		X		Provide salt hoisting and handling equip. at existing main shaft, and, if necessary, provide additional shafts for hoisting and handling salt as required.

TABLE 10.1 (Continued)

System/Facility	System Adequate (1)	System Easily Expandable (2)	System Expandable with Difficulty (3)	Remarks
4. Waste Handling System				
a. Cask handling subsystem	X			Same as 2.a.
b. Canister unloading/transfer subsystem	X			Same as 2.a.
c. Canister emplacement subsystem		X		Mine additional space, and additional transporter(s).
d. Retrieval subsystem			X	See footnote (4).
5. HVAC/Confinement Systems				
a. Waste receiving bldg. primary and secondary confinement zones	X			Same as 2.a.
b. Waste receiving bldg. support areas		X		Additional partial systems can be supplied with expansion of office and change room areas as required (Ref. 2.a).
c. Mine ventilation	X			Probably adequate for expanded facility, depending on criteria for design and operation of full-scale repository. Expansion might be accommodated in BSPP supply and exhaust shafts; if not, new shafts would be required.
d. Other surface facilities		X		If expansion of structures is required, additional ventilation would be designed into them.
6. Electrical System				
a. Normal power		X		Capability for expansion will be designed into BSPP system.
b. Emergency power		X		Same as 6.a.
c. Uninterrupted power		X		Same as 6.a.

TABLE 10.1 (Continued)

System/Facility	System Adequate (1)	System Easily Expandable (2)	System Expandable with Difficulty (3)	Remarks
7. Utilities and Services				
a. Railroads		X		Additional track capacity may be required; allowance has been made in BSPP design for this extension.
b. Water		X		If additional capacity is required, BSPP design will accommodate it.
c. Fuel		X		Same as 7.b.
d. Sanitary waste	X			Adequate if personnel complement does not exceed BSPP requirements significantly. Can easily add another package unit if necessary.
e. Site-generated contaminated waste treatment	X			
8. Monitoring/Surveillance System	X			

- (1) Defined as meaning BSPP design contains adequate capacity to accommodate full-scale repository requirements.
- (2) Defined as permitting expansion to full-scale requirements without prolonged interruption of waste disposal operations.
- (3) Defined as requiring significant interference with and interruption of waste disposal operations.
- (4) Based on past criteria for full-scale repository design and operation, viz., canisters up to 24 in. o.d. and 10 ft long, and currently envisioned retrieval concepts, retrieval capability would require serious and expensive modifications to the BSPP facilities, including the following:
- (a) Special casks to accommodate the canister plus salt block containing the canister (estimated to be 32 in. o.d. and 13 ft long).
 - (b) Larger (and therefore, new) diameter waste shaft, heavier capacity hoist, and larger transfer cell with additional inside head room and heavier handling equipment.
 - (c) Recan capability and increased headroom in the mine-level receiving station.
 - (d) Increased headroom, probably, in disposal rooms and, perhaps, in mine entries.
 - (e) Possibility of increased headroom in both the transfer gallery and the cask unloading areas.

11. APPENDICES

11.1 High-Level Waste Projections

Projections of the industrial radioactive wastes generated by the nuclear fuel economy over the remainder of this century have been made. The waste estimates tabulated in this section are based on those projections, which are explained more fully elsewhere by Blomeke and Nichols.¹ For purposes of this conceptual design, it was assumed that all these projected wastes would be delivered to the BSPP, aged 10 years after removal from the reactor, and at the rate projected, except that the maximum rate is assumed to be 100 canisters per week.

¹ORNL-TM-3965, Projections of Radioactive Wastes to be Generated by the U. S. Nuclear Economy, J. O. Blomeke, C. W. Kee and J. P. Nichols, February 1974.

Table 11.1 PROJECTIONS OF NUCLEAR POWER CAPACITY AND WASTE SHIPMENTS TO BSPP

Fiscal Year	Est'd. U. S. Nuclear Capacity GWe (Net) (Avg. in Fiscal Year)	Metric Tons Spent Fuel		Waste Shipped (Cu. Ft)		Waste Thermal Power Shipped (kW)		Megacuries Shipped		No. of Canisters Shipped*		No. of Cask Shipments**	
		Annual	Accum	Annual	Accum	Annual	Accum	Annual	Accum	Annual	Accum	Annual	Accum
1971	5												
1972	8												
1973	17												
1974	31	100	100										
1975	45	400	500										
1976	55	1100	1600										
1977	63	1700	3300										
1978	76	2032	5332										
1979	94	1959	7291										
1980	114	2401	9692										
1981	134	3047	12,739										
1982	159	3546	16,285										
1983	185	4118	20,403										
1984	213	4293	24,695	200	200	66	66	19	19	32	32	3	3
1985	245	4921	29,617	600	1000	281	347	81	100	127	159	11	14
1986	281	5468	35,085	2200	3200	836	1183	241	341	350	509	29	43
1987	318	6015	41,100	3400	6600	1473	2656	425	766	542	1051	45	88
1988	362	6768	47,863	4064	10,664	1934	4590	557	1323	647	1698	54	142
1989	408	7568	55,435	3933	14,597	1878	6468	542	1865	626	2324	52	194
1990	453	8415	63,851	4829	19,426	2599	9067	651	2516	769	3093	64	258
1991	504	9148	72,999	6124	25,550	3769	12,836	840	3356	975	4068	81	339
1992	559	10,256	83,255	7238	32,788	5046	17,882	1024	4380	1153	5221	96	435
1993	617	11,104	94,359	8501	41,289	6240	24,122	1201	5581	1354	6575	113	548
1994	676	12,085	106,444	8977	50,266	7173	31,295	1303	6884	1430	8005	119	667
1995	740	12,988	119,432	10,520	60,786	8465	39,760	1506	8390	1675	9680	140	807
1996	807	14,060	133,492	11,893	72,679	8890	48,650	1696	10,086	1894	11,574	158	965
1997	879	15,077	148,569	13,320	85,999	9314	57,964	1882	11,968	2121	13,695	177	1142
1998	955	15,548	164,117	15,159	101,168	9838	67,802	2151	14,119	2416	16,111	201	1343
1999	1033	16,782	180,899	17,182	118,350	10,260	78,062	2433	16,552	2736	18,847	228	1571
2000	1117	17,580	198,479	18,354	137,714	10,773	88,835	2742	19,294	3084	21,931	257	1828
2001	1201	19,219	217,698	21,335	159,049	11,214	100,049	3032	22,326	3397	25,328	283	2111
2002	1287	19,975	237,673	24,050	183,109	12,014	112,063	3427	25,753	3832	29,160	319	2430
2003	1376	21,132	258,805	26,350	209,459	13,151	125,214	3753	29,506	4196	33,356	350	2780
2004	1467	22,583	281,388	29,026	238,485	14,442	139,656	4125	33,631	4622	37,978	385	3165
2005	1561	23,133	304,521	31,606	270,091	15,714	155,370	4496	38,127	5033	43,011	419	3584
2006				34,656	304,747	17,161	172,531	4922	43,049	5519	48,530	460	4044
2007				37,616	342,363	18,566	191,097	5336	48,385	5990	54,520	499	4543
2008				39,590	381,553	19,306	210,403	5567	53,952	6304	60,824	525	5068
2009				43,166	425,119	20,863	231,266	6036	59,988	6874	67,698	573	5641
2010				45,943	471,062	21,926	253,192	6364	66,352	7316	75,014	610	6251

*Assumes waste canisters 12 in. diam and 10 ft long, containing 6.28 ft³ of solidified waste each.

**Assumes 12 waste canisters per cask shipment.

11.2 High-Level Waste Shipping and Shipper/Owner - BSPP Interfaces

Following are criteria for acceptance of the waste that is to be received at the BSPP. These criteria are tentative and may be revised as design of the BSPP advances.

11.2.1 High-Level Waste Acceptance Criteria

The dry, solid waste shall be chemically, thermally, and radiolytically stable when packaged in canisters meeting the specifications of Sect. 11.2.2, and when exposed to the storage conditions specified below.

11.2.1.1 Solidified Waste.--The solidified waste shall meet the following specifications upon its receipt at the pilot plant:

- a. The thermal conductivity, density, heat capacity, and homogeneity of the solid shall be such that (1) when buried in an infinite medium of crushed salt containing 30 vol % air at an initial temperature of 400°F ($\rho = 98 \text{ lb/ft}^3$; $k = 0.2 \text{ Btu/hr.ft.}^\circ\text{F}$; $C_p = 0.21 \text{ Btu/lb.}^\circ\text{F}$), the temperature at no point within the waste will exceed that to which it has been exposed during processing; and (2) the temperature of the outer surface of the canister will not exceed 600°F when standing in air at an ambient temperature of 80°F.

- b. The waste solids shall be compatible with moist salt to the extent that they do not react to form unstable solids, liquids, or noxious gases at temperatures up to the maximum value achieved at the waste-salt interface when the waste is buried in an infinite medium of crushed salt containing 30 vol % air initially at 400°F.
- c. The identities and initial concentrations of those isotopes which, when their contributions are summed, account for at least 90% of the total thermal power of the waste at any time within 10⁵ years after reprocessing shall be listed.
- d. In no case shall (1) the initial thermal power of any canister exceed 5000 watts; or (2) the neutron source-strength of any canister exceed 1×10^9 neutrons/sec.

11.2.1.2 Nuclear Criticality Considerations.--A tightly-packed array containing an unlimited number of identical canisters in the condition that will prevail upon receipt at the BSPP shall be subcritical when dry, or with any degree of water moderation and reflection.

11.2.2 Waste Canister Specifications

Upon receipt at the BSPP, the canisters shall meet the specifications given below. In the analysis for conformance, all factors that might influence the integrity of the canister must be considered, including the previous conditions of corrosion, temperature, and pressure to which it has

been exposed, and the formation of gases that may have occurred since sealing as a consequence of radiolytic decay of the waste.

- a. The waste shall be encapsulated in a sealed cylindrical canister with an outside diameter between 6 and 14 in., and an overall length (including connector pin) between 2 and 10 ft. (Canisters with other than circular transverse cross-sections and with dimensions falling within this range can be accepted upon approval.) The total weight of the canister shall not exceed 8000 lb.
- b. The canister shall be fabricated of a material designed to maintain the waste in a "leak-proof" condition* following a free fall of 10 ft onto solid concrete so as to strike its bottom surface; it shall also be designed to remain "leak-proof" when standing in air at 80°F and 50% relative humidity for 10 years.
- c. The canister shall have dimensional tolerances such as to allow it to fit within a cylindrical cavity 14.50 in. in diameter by 10 ft - 0 in. long.
- d. The outer surface of the canister shall not be contaminated with transferable radioisotopes in excess of 300 dis/min/dm² alpha radiation, and 10,000 dis/min/dm² beta-gamma radiation, as determined by wiping the external surface with an absorbent material and measuring the activity thereon.

* A canister is considered to be in a "leak-proof" condition when it exhibits a leak rate $< 10^{-7}$ atm-cm³/sec, as measured with a helium leak detector.

- e. Each canister shall have a connector pin of the type shown in Fig. 11.1, attached to the top of the canister. (Ref. subsection 11.2.4).

11.2.3 Shipping Cask

The cask design limitations and definitions of facility-cask interfaces set forth herein are presented to attain compatibility between the high-level waste facility conceptual design and the privately-designed shipping cask and its appurtenances. Cask designs shall be submitted to the AEC for compliance with these limitations, prior to fabrication.

11.2.3.1 Cask Handling Limitations

- a. The weight of the shipping cask, lifting bail, contents, and any other appurtenances shall not exceed a 110-ton single-lift requirement.
- b. The shipper/owner of the cask shall provide the rail car for transporting the cask to and from the BSPP. The shipping cask-rail car package shall not exceed AAR clearance maximums:
 - o Width: 10 ft 8 in.
 - o Height: 15 ft 1 in. from T.O.R.

The shipper/owner shall provide all supporting structures and tie-downs required to secure the cask to the rail car.

Figure 11.1

Proposed Waste Canister Connector Pin

- c. The shipper/owner of the cask shall furnish slings, bails, and other lifting devices, as required, to upend and remove the cask from the rail car and to replace the cask on the rail car after the high-level waste is discharged. In this regard, the waste receiving facility will provide a 110-ton-capacity crane, with a 15-ton auxiliary hoist, to serve the cask unloading area. The lifting devices shall be suitable for moving the cask about the area and for lowering and raising the cask through a 12-ft by 12-ft hatch over the transfer gallery. The slings, bails, and other lifting devices shall be capable of removal if so required during shipment or handling of the cask at the waste receiving facility. The shipper/owner shall provide any special tools, jigs, or adapters that may be required for cask handling, including the removal of the shield plug retainer.
- d. The facility-furnished 110- and 15-ton crane will have a span of 39 ft 0 in., and top of crane rail will be 30 ft 0 in. above finished floor elevation. Top of the rail car tracks will be 4 ft 2 in. below finished floor elevation. The maximum 110-ton hook height above the rail car tracks will be 36 ft 0 in. and the hook height above the cask set-down pad will be 30 ft 10 in. Wheel clamps to prevent rail car movement during cask lifting operations and car pullers to move the rail car in and out of the cask unloading area will be provided by the BSPP.

11.2.3.2 Cask Design Limitations

a. Dimensional Limitations - see Fig. 11.2.

- o The maximum out-to-out dimension of the cask, measured diametrically, shall not exceed 10 ft 0 in.
- o The maximum height of the cask, excluding the bail and any removable protective device, shall not exceed 15 ft 0 in.
- o The cask cavity will have a nominal diameter of 5 ft 6 in. and accommodate waste canisters 10 ft 0 in. long, including connector pins.

- #### b. Sealing Surface on Top of Cask.--The cask design shall include a 2-in.-deep by 5-in.-wide (minimum) groove to accept the seal provided by the BSPP as shown in Fig. 11.3. The finished surfaces on top of the cask shall be as shown. The 1-in. clearance^{dimension} is to allow for misalignment with the port. The 1/4-in. (minimum) dimension is to provide a step to inhibit radiation streaming through to the elastomeric seal. Smaller casks shall retain the basic geometry and dimensions of the seal area (see Fig. 11.4). An adapter ring, furnished by the cask shipper/owner, may be used to provide cell mating dimensions for smaller casks.

The cask-to-transfer port sealing surface on the top of the cask shall be protected against damage during shipment or handling of the cask.

Figure 11.2

Shipping Cask Concept

Figure 11.3

Sealing Surface on Top of Cask

Figure 11.4

Sealing Surface on Top of Cask

- c. Cask Shield Plug Interface with the Handling Capability of the BSPP.--The cask handling concept presumes that the cask would be lowered into the transfer gallery, vented, the nuts securing the shield plug retainer removed, the shield plug retainer removed by the 110-ton crane (15-ton hook), and the cask-to-port seal support ring placed on top of the cask before moving it under the transfer cell port. The cask shield plug interface requirements include the following:
- o The design configuration and the method of retention of the shield plug should recognize that the facility does not provide a means of rotating the shield plug for hole-stud alignment within the transfer cell or in the access port between the transfer cell and cask.
 - o The shield plug shall be provided with lifting eyes permanently affixed to the plug and suitably protected from impact. A concept embodying these features is shown in Fig. 11.5. The lifting eyes shall be positioned so that, when the shield plug is supported by the lifting eyes, the plug will be balanced to permit easy removal from or re-entry to the cask without external assistance.

Figure 11.5

Shield Plug Arrangement

- o The shield plug shall be provided with sufficient taper or guidance capability that the plug will enter a cask positioned 1 in. off true center below the transfer cell hoist.
 - o Provision shall be made for lifting the shield plug retainer by sling attachment from the crane.
 - o The seal between the cask shield plug and the cask shall be retained by the weight of the shield plug after the retaining devices have been removed preparatory to moving the cask through the transfer gallery and up to the cell port. The seal shall be reestablished by the plug weight when the plug is replaced on the empty cask and shall be maintained until the retaining devices are reinstalled just prior to lifting the cask out of the transfer gallery.
- d. Cask Fabrication Tolerances.--The finished surfaces on top of the cask, shown on Fig. 11.3, shall be flat within 0.060 in. tolerance in runout. No radial tool marks will be permissible on the surface contacting the seal.
- e. Cask Atmosphere and Cooling
- o The atmosphere in the cask during shipment to the BSPP is to be a nontoxic inert gas. No casks will be accepted which have liquid in the cavity where the waste canisters are stored during shipment.

- o The cask shall be equipped with means for removal of its sensible heat by circulation of cooling water through an external jacket or through internal channels in the gamma shield.

11.2.4 Waste Canister Connector

The proposed waste canister connector shown on Drawing Nos. M-11362-EK-100D through M-11362-EK-103D is designed for use both at the BSPP and at the waste processing plants. This connector or any other lifting device proposed for use at the pilot plant must meet the following criteria:

- It must be designed for 8000-lb load.
- It must be capable of remotely attaching to, or releasing from, a waste canister connector pin without radial orientation.
- The load must be transmitted from the waste canister pin to the lifting hook without being transmitted through any additional clevises, screwed joints or bolted assemblies within the connector.
- The waste canister must not be dropped during its handling under any foreseeable circumstances, either at the waste generation site or at the BSPP.
- Activation of the connector may be by electrical, hydraulic or pneumatic means.
- The connector must be no more than 6 in. in diameter and no taller than 10 in. from the base to the center line of the cable attachment to the connector.
- The connector must be resistant to damage from nuclear radiation and thermal heat of the waste canisters.
- It must be capable of attachment to and removal from cell cranes and transporter cable using remote operations.
- It must be easily maintained and repaired, possibly within a glove box.
- It must be capable of operation underwater.

11.3 Structural and Systems Design

11.3.1 Design Classification

Certain structures, components, and systems of the BSPP will require a degree of design, verification, inspection, and documentation over and above that applied in the course of normal engineering, procurement, and construction. To assure that such items are properly identified and are given the required special treatment, all structures, components, and systems of the BSPP will be given one of the following classifications:

Class I - Those structures, components, and systems, including instruments and controls, whose failure might cause the release of excessive amounts of radioactivity or that are essential to safe shutdown of operations without endangering the public health or safety during or following a Maximum Credible Event (MCE).

Class II - Those structures, components, and systems important to the operation of the BSPP but not essential to the safe shutdown or long-term safety of the facility following a MCE.

Class III - Those structures, components, and systems whose failure will not result in release of excessive amounts of radioactivity and whose operation is not essential to safe operation of the BSPP.

11.3.2 Maximum Credible Events

The BSPP shall maintain required functional capability as defined in 11.3.1, Design Classification, during or after the following events.

11.3.2.1 Earthquake.--"Design Basis Earthquake" (DBE), also referred to as a "Safe Shutdown Earthquake," (SSE) for the BSPP will be established subsequent to site selection. Local geologic and soils data

shall be evaluated in determining free field vibratory ground motions for the DBE. The "Operating Basis Earthquake" (OBE) will produce ground accelerations one-half that of the DBE.

During Title II engineering, the architect-engineer is to select a method for dynamic analysis and shall present an explanation of the method selected and justify its use. Unless sufficient justification is presented for deviating, the damping values presented in AEC Regulatory Guide 1.60 shall be used in the analyses.

11.3.2.2 Wind.--The "Design Basis Wind" (DBW) for the BSPP will be established subsequent to site selection. Local and regional meteorology will be reviewed in establishing the DBW.

11.3.2.3 Tornado.--The "Design Basis Tornado" (DBT) will be established subsequent to site selection. The DBT is generally considered as that tornado which has a horizontal rotational wind speed of 300 mph, a translational wind speed of 60 mph, and a pressure drop of 3 psi in 3 seconds acting simultaneously. Included in the effects are tornado-generated missiles, represented typically by a piece of timber of substantial cross-sectional area and length, a piece of steel pipe, or a light automobile.

11.3.2.4 Flood.--The "Design Basis Flood" (DBF) will be established subsequent to site selection. The DBF shall consider the possibility of flooding from climatological events as well as local runoff or mechanical failures such as pipeline ruptures.

11.3.3 Design Requirements

The BSPP will be designed to accommodate the specific loadings as defined herein.

- a. Design Dead Load. Total weight of all empty equipment, structures, insulation, piping, and conduit.
- b. Operating Load.--Dead load plus the weight of any liquids or solids normally present within systems or piping during operation, including the weight of all permanently stored operating materials.
- c. Live Load.--Weight of all movable loads, including personnel, cranes, stored materials, maintenance equipment, parts of dismantled equipment, etc.
- d. Thermal Load.--Forces caused by changes in temperature, including those resulting from vessel or piping expansion or contraction and from expansion or contraction of structures.
- e. Load Combinations.--Combinations of loads from a., b., c. and d. are to be applied in a manner meeting all the requirements of the codes listed in Table 11.2. The proposed load combinations will be presented for approval with the dynamic analysis method.

TABLE 11.2 DESIGN CODES

	STRUCTURAL	
	Concrete	Structural Steel
Category I (based on abnormal/ extreme environ- mental category per Section III, Division 2)	Section III, Division 2	AISC except that allowable stress limits for the service load com- binations involving seismic shall not include the one-third increase normally allowed by AISC. Include DBE in load combination.
Category II	ACI Code	AISC except that allowable stress limits for the service load com- binations involving seismic shall not include the one-third increase normally allowed by AISC. Include OBE in load combination.
Category III	UBC	AISC (use UBC wind and seismic criteria)

PIPING

Category I	Section III, Class 1
Category II	Section III, Class 2
Category III	A.N.S.I. B 31.1.0

Code Titles

Section III, Division 2	- Proposed Standard Code for Concrete Reactor Vessels and Contain- ments, Division 2 of Section III ASME Boiler and Pressure Vessel Code (ACI-ASME)
AISC	- Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, American Institute of Steel Construction (AISC)
UBC	- Uniform Building Code, International Conference of Building Officials
Section III	- ASME Boiler and Pressure Vessel Code, Section III
A.N.S.I. B 31.1.0	- American National Standards Institute Code for Pressure Piping - Power Piping

11.4 List of Applicable Drawings

<u>Dwg. No.</u>	<u>Title</u>
A-101-3 (KE)	Waste Receiving Building - Floor Plans
A-102-3 (KE)	Waste Receiving Building - Sections
C-102-3 (KE)	Plot Plan
E-11362-ED-030-E (ORNL) ¹	Electrical One-Line Diagram
H-11362-EG-012-E (ORNL) ²	Mine Ventilation Flow Diagram
HV-4 (KE)	Mine Ventilation Exhaust - Central Filter Station - Plans and Sections
HV-101-3 (KE)	Waste Receiving Building - Ventilation Flow Diagram
M-106-3 (KE)	Transfer Cell Waste Canister Handling - Elevation
M-107-3 (KE)	Transfer Cell Waste Canister Handling - Sections
M-108-3 (KE)	Mine-Level Receiving Station Canister Handling - Elevation
M-109-3 (KE)	Mine-Level Receiving Station Canister Handling - Sections
M-111-3 (KE)	Shipping Cask Handling - Arrangement and Details
M-112-3 (KE)	Cranes and Hoists
MI-11362-EC-011-E (ORNL) ³	Mine Development Plan
MI-11362-EC-012-E (ORNL) ⁴	Main Shaft - Underground Facilities, Skip and Cage
P-101-3 (KE)	Utility Flow Diagram
P-102-3 (KE)	Process Waste Flow Diagram

¹Based on KE drawing SK-E-101-3.

²Based on KE sketch HV-3.

³Based on KE drawing MI-101-3.

⁴Based on KE drawing MI-103-3.

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