AN ABOVE-GRADE LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY: THE DESIGN AND LICENSING STATUS OF THE CENTRAL INTERSTATE COMPACT FACILITY

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ABSTRACT

The Central Interstate Compact low-level radioactive waste disposal facility being developed near Butte, Nebraska, is scheduled to be the first operational above-grade LLRW disposal facility in the United States.

Two types of above-grade structures are planned, one for the Class A waste and another for the Class B and C waste. The enclosed design of the Class A waste disposal structure permits waste placement independent of weather conditions. Approximately 20 of these structures are to be built during the 30 year operational life of the facility. The Class B and Class C waste will be disposed of in a single reinforced concrete structure that has 32 separate cells. After 30 years of operation when the structures are filled and sealed closed, they will be covered with a multilayered engineered closure cap that minimizes water infiltration and provides for long-term stability.

The Safety Analysis Report and Environmental Report (license application documents) for the facility were submitted to the state of Nebraska for review in July 1990. Present plans call for the facility to be operational in 1995.

INTRODUCTION

The Central Interstate Compact (CIC) Commission has authorized US Ecology and its prime subcontractor, Bechtel National, Inc., to develop a low-level radioactive waste (LLRW) disposal facility to be located near Butte, Nebraska. The facility is being sited, designed, constructed, operated, closed, and monitored in accordance with Nebraska Department of Environmental Control (NDEC) Title 194 (1) as promulgated from 10 CFR 61 (2), and as supplemented by the state of Nebraska. Nebraska regulations specifically exclude the use of traditional shallow-land burial. The facility will use above-grade earth-mounded concrete structures for disposal of the LLRW. An environmental report (ER) has been prepared following the guidance contained in NRC Regulatory Guide 4.18 (3). A safety analysis report (SAR) has been prepared to conform with the guidance contained in NUREG 1199 (4). Both the SAR and the ER were submitted in July 1990 as part of the license application. Present plans call for the facility to be operational in 1995.

SITE SELECTION AND CHARACTERIZATION

Land areas within Nebraska (the first host state) were reviewed for their suitability as LLRW disposal sites. Selection of a site was based on criteria that included an analysis of the following: proximity to dedicated lands, flood plains, population centers, active faults, groundwater and surface water; interest from local communities; and geologic, environmental, topographic, and engineering data. A Citizens Advisory Committee (CAC) performed a detailed review of the appropriateness and ranking given to the criteria used to make the evaluation. The initial set of areas evaluated is referred to as potential areas. Within these areas, 111 specific potential siting areas were selected. A further evaluation based on a review using the factors provided above, as well as land availability, arrived at 3 candidate sites which are in Nemaha, Nuckolls, and Boyd County.

A characterization program was then performed for the three candidate sites. Characterization included drilling boreholes, installing observation and monitoring wells, performing in situ pumping tests, surveying surface hydrologic conditions, establishing meteorological stations and air monitors, and surveying ecological and environmental conditions. In addition, samples of geologic, geotechnical, radiological, and chemical material were collected for laboratory analysis and for establishing the site preoperational condition and background radiation levels in various media. A survey of local land use, demography, socioeconomics, and ambient noise levels was also performed. Evaluation of the data collected during these site characterizations led to selection of the preferred site which is located in Boyd County near the community of Butte, called the Butte site. More detailed characterization is continuing at this Butte site.

FACILITY DESIGN AND OPERATION

The Butte site (Fig. 1) is approximately 1.6 x 0.8 km (1 by 0.5 miles), is located in north central Nebraska, and is in a region of low seismic activity. The watershed upgradient of the site is less than 2.6 E + 06 m^2 (1 square mile). The site is relatively flat, with an average change in elevation of 3.4 E-03 m/m (18 ft per mile). Beneath the site is a layer of Pierre Shale, approximately 152 m (500 ft) thick. This thick layer of impermeable material prevents nuclide transport into the deep lying water-bearing permeable beds of the Early Cretaceous Dakota Group that lie approximately *305 m (1000 ft)* beneath the site. The Pierre Shale is overlain by a series of silt and clay layers (Fig. 2), with an average total thickness of approximately 9.1 m (30 ft).

Two separate designs of above-grade concrete structures are planned, with one design for disposal of the Class A waste and the other design for disposal of the Class B and C waste. At closure, the facility is expected to hold approximately 7.1 E + 04 m^3 (2.5 million ft^3) of LLRW containing approximately

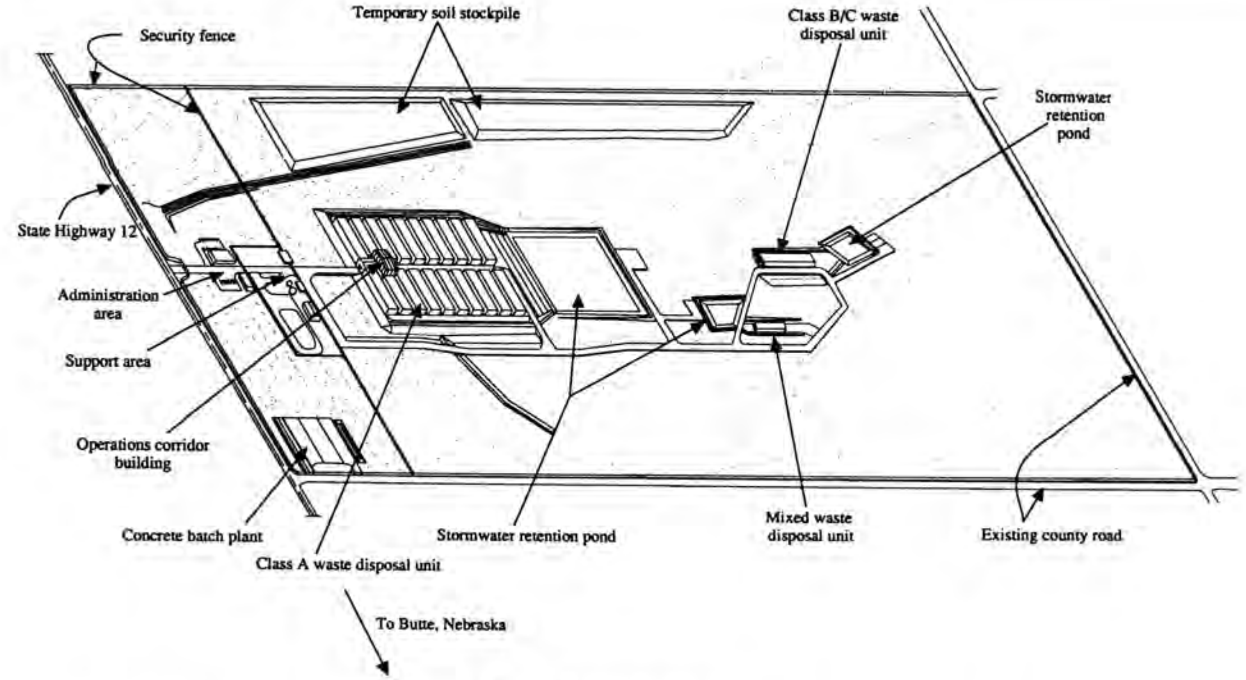

Fig. 1. Butte site layout.

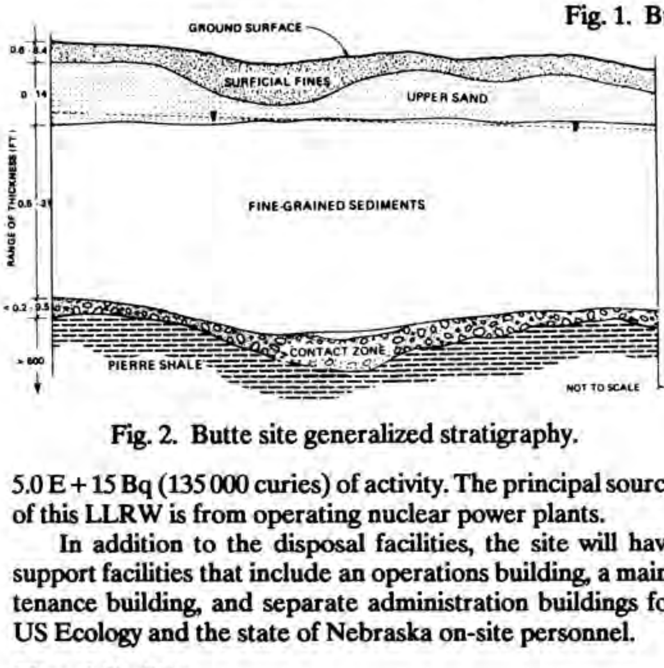

Fig. 2. Butte site generalized stratigraphy.

5.0 E + 15 Bq (135 000 curies) of activity. The principal source of this LLRW is from operating nuclear power plants.

In addition to the disposal facilities, the site will have support facilities that include an operations building, a maintenance building, and separate administration buildings for US Ecology and the state of Nebraska on-site personnel.

Class A Facility

The Class A waste disposal facility consists of 20 separate reinforced concrete structures or cells. The structures are designed to accommodate normal operation and construction loadings as well as severe loadings that could be caused by the maximum credible earthquake, tornado wind loads, and associated tornado missiles. Long-term durability and structural integrity is ensured by designing and inspecting the facility in accordance with the guidance contained in NUREG 5041 (5).

The 20 cells will be built in 2 rows of 10, with the cells in a row separated from each other by 6 m (20 ft), and the 2 rows separated by 15 m (50 ft). Each cell is approximately 85 x 18 x 6 m (280 ft long by 60 ft wide by 20 ft high), with walls and roof that are 0.9 m (3 ft) thick and a basemat that is 1.4 m (4.5 ft) thick. Each cell is divided into 2 bays by a 0.9 m (3-ft) thick interior wall that runs the length of the structure. Access to the cells is through two side openings measuring 5.6 x 7.6 m (19 ft high by 25 ft wide) to accommodate forklift trucks and two 9.3 m^2 (100 ft^2) roof openings to receive waste from an overhead crane.

Each operating cell has a ventilation system that includes a distributed fresh air supply and a filtered exhaust having two high efficiency particulate air (HEPA) filters and a charcoal filter. The ventilation system ensures that airborne contamination levels within the cell are maintained within acceptable levels for waste placement personnel and also ensures that emissions from the cell to the environment are monitored and minimized.

Initially four of these structures (two in each row) will be built, with additional ones added as existing structures become filled. The operating structures (Fig. 3) are connected by an enclosure that shelters the waste transport trailer and waste-handling equipment such as cranes and forklifts. The enclosure permits waste handling under adverse weather conditions.

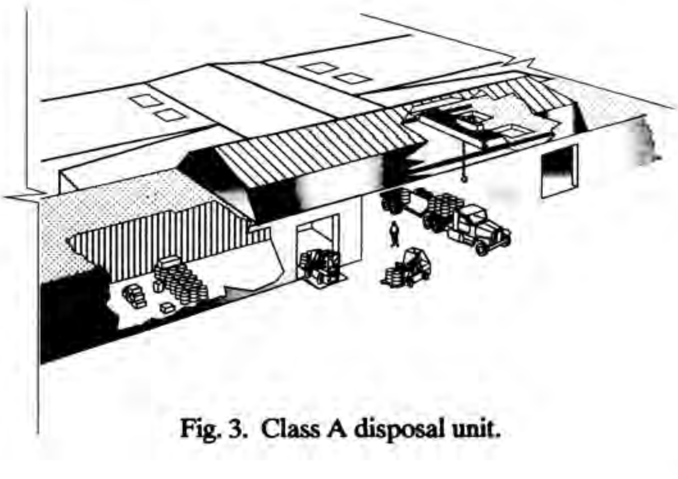

Fig. 3. Class A disposal unit.

Most of the waste will be moved from the transport trailer to the disposal location inside the cell in a continuous operation using forklifts. This one-time handling of waste minimizes occupational exposure. Class A waste containers that may create occupational exposures above ALARA guidance will be transported into a Class A structure using a remotely operated overhead crane and then placed inside the structure using a stacker crane that has remote operation capability.

Critical input regarding the design was received from the CAC including all-weather waste handling and remote operability of the cranes.

Class B/C Facility

The waste disposal facility for the Class B and C waste is a *single reinforced* concrete structure (Fig. 4) that is highly compartmentalized, making the waste readily retrievable during the operational and post closure period. This structure is approximately 91 x 18 x 9.1 m (300 ft long by 60 ft wide by 30 ft high). The external walls are 1.1 m (3.5 ft) thick and the basemat is 1.4 m (4.5 ft) thick. Within this structure are 32 cells, each separated by a 1.1-m (3.5-ft) thick concrete wall that runs the length of the structure and a series of 0.5-m (1.5-ft) thick concrete walls that run the width of the structure. Within each cell are six hollow concrete cylinders, with each cylinder having an internal diameter of approximately 2 m (6.5 ft). The region between the cylinders is filled with sand. Each cell has three roof panels that may be removed to permit waste placement. Each roof panel is approximately 10 x 2.4 x 1 m (32 ft long by 8 ft wide by 3 ft thick). A large crane that straddles the facility is used to remove the roof panels, place the waste inside the concrete cylinders, and replace the roof panels. This crane will also have remote operation capability so that occupational exposure can be minimized.

Drainage Systems

Surface drainage from the operating Class A and Class B/C structures is routed to retention ponds that are sized to hold the maximum 4-day rainfall within a 100-year period. Prior to release of this water to the off-site surface drainage system, the water in these ponds is sampled, and treated if necessary, to ensure that appropriate discharge standards are met.

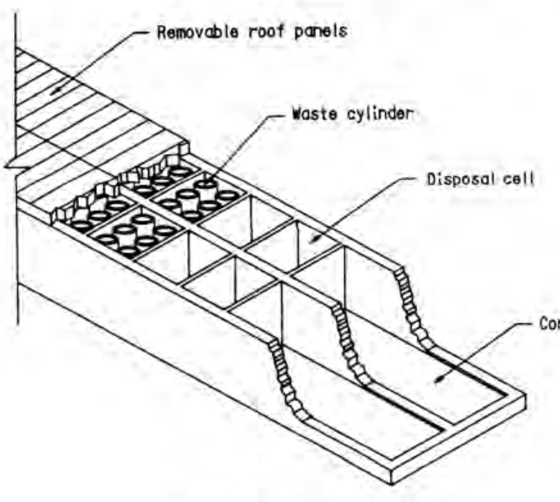

Fig. 4. Class B/C disposal unit.

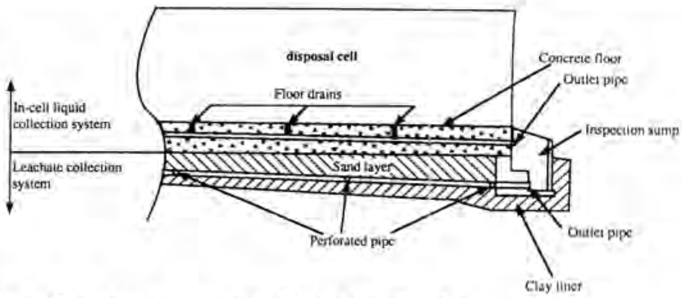

Fig. 5. Class A unit in-cell liquid collection system and leachate collection system.

In-cell liquid collection systems (Fig. 5) are provided in both the Class A structures and the Class B/C structure. The in-cell liquid collection systems consist of drains that gather any liquid that may accumulate within the structures and route the liquid to inspection sumps. This collection system is the primary monitoring system that will remain operable after facility closure.

The Class A and Class B/C structures also have leachate collection systems (Fig. 5) that are installed below the concrete floor slab of the structures. These leachate collection systems consist of perforated drainpipes placed in a sand layer that is located above a 0.9-m (3-ft) thick graded clay layer. The sand permits drainage to the clay interface of any liquid that may infiltrate through the ground surrounding the cell or through the floor slab of the disposal cells. The perforated drainpipes placed immediately above the graded clay layer collect any liquid that may accumulate. The pipes route the collected liquid to inspection sumps. This collection system serves as a secondary monitoring system that will also remain operable after facility closure.

Liquid that may accumulate in the collection sump of either the in-cell liquid collection systems or the leachate collection systems is analyzed and treated, as appropriate, prior to release.

Although not strictly a drainage system, a series of groundwater monitoring wells located upgradient and downgradient of each disposal unit serve as the tertiary monitoring system to detect leakage from the facility.

Closure Cap

At the completion of disposal operations at the site, a multilayered engineered closure cap (Fig. 6) will be constructed over the Class A structures, and a separate closure cap will be constructed over the Class B/C structures. These closure caps are built over the reinforced concrete structures by orderly placement of the following layers: (1) a sand backfill around and on top of the structure, (2) a clay layer, (3) a layer of concrete, (4) another layer of sand, (5) a geotextile filter, (6) a native soil cover with vegetation. A layer of rock armor is also placed on the sloping sides of the closure caps.

The native soil layer and geotextile fabric provide for erosion protection and water filtering to minimize clogging of the sand drainage layer below. The upper sand layer provides for lateral water drainage away from the waste below and to the toe of the cap. Drainage pipes in the toe of the cap transport the water to the site watercourse. The concrete layer serves as an additional intrusion barrier and hardens the cap

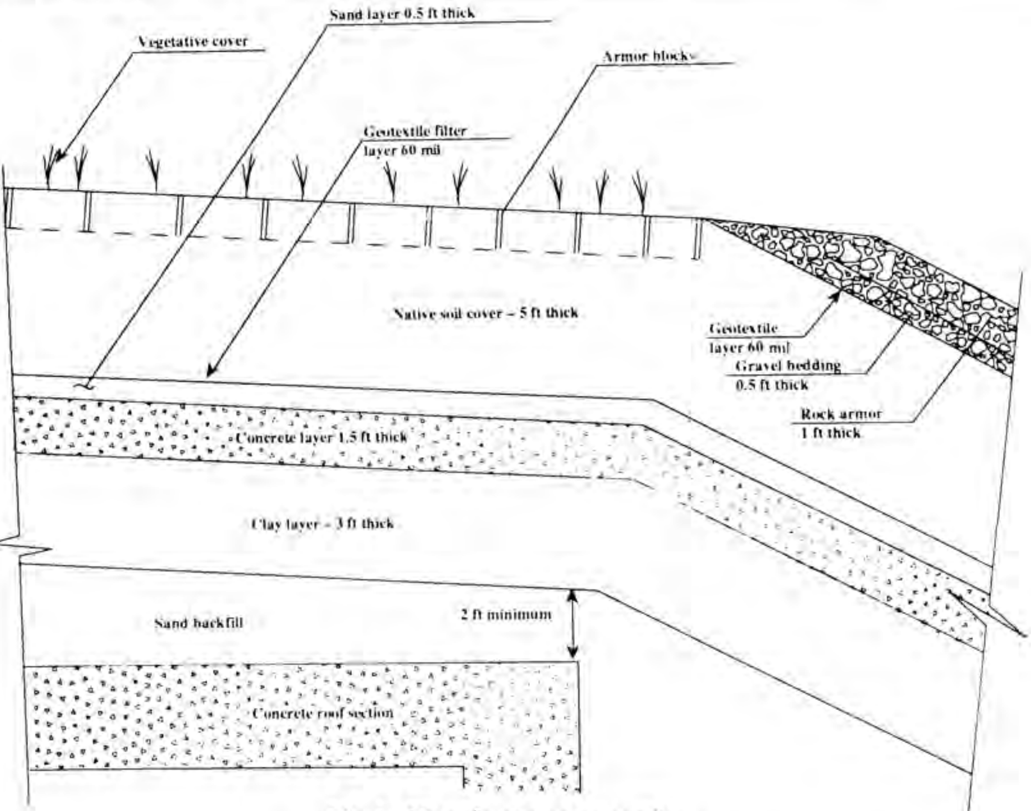

Fig. 6. Closure cap cross-section.

against long-term erosion. The clay layer serves as the next barrier to minimize water infiltration into the cells. The sand backfill around the structures provides a stable 4:1 slope for the cap configuration and provides a free-draining layer that minimizes the potential contact of soil moisture with the disposal structure. This sand also provides a permeable material for any infiltrating moisture to drain to the leachate collection system beneath the structure. These caps are designed to minimize water infiltration; deter plant, animal, and human intrusion; and maximize the long-term stability of the waste emplacement.

PERFORMANCE MONITORING AND ASSESSMENT

Monitoring of the surface water, groundwater, and air during facility operation will ensure that releases are within permissible limits. As mentioned above, surface water drainage from the disposal structures is analyzed prior to discharge. In addition, the surface water in neighboring creeks is sampled regularly. Groundwater is analyzed by taking samples from monitoring wells. The air is sampled by collecting particulates on filters and water vapor on silica gells. Additional environmental monitoring includes measuring radiation levels around the site using thermoluminescent dosimeters (TLDs) and by analysis of collected soil and vegetation samples. Air emissions from the ventilated Class A cells are monitored using a continuous air monitoring system.

Air emissions from normal operations have been modeled with dose calculations performed using the AIRDOS code and the GENII code. In both cases, model predicts that the emissions will be below values that typically require a National Emissions Standards Hazardous Air Pollution (NESHAP) discharge permit.

The facility has been analyzed for the effects of postulated design basis accidents described in NUREG/CR 4370 (6) which include a dropped-waste container and a fire on a transport vehicle accidents. The source terms generated by these postulated design basis accidents are derived using the guidance of NUREG/CR 4370 and the nuclide transport and consequent dose to man are modeled using the GENII computer code. The GENII code is described in PNL-6584 (7). The predicted exposures from the postulated accidents are well within regulatory limits.

The long-term performance of the facility is also modeled using the guidance of NUREG/CR 4370. The bounding scenario for this evaluation is one in which an individual drills a well near the site and subsequently drinks the water, waters his garden, and provides water to livestock and poultry from this well.

The most involved part of the performance assessment is the modeling of the nuclide transport into and through a soil configuration that represents the site. A modified version of the computer code, BLT (Breach, Leach, and Transport), is used to model the release of nuclides into the soil. A detailed finite element model of the site soil stratigraphy and hydrogeologic properties is created using the FEMWATER code, which is then used to model the transport of the nuclides through the ground to a postulated well. BLT and FEMWATER are described in NUREG/CR-5387 (8). GENII is subsequently used to evaluate the dose to man.

CURRENT LICENSING STATUS

The SAR and ER were submitted to the state of Nebraska in July 1990. The state provided first-round questions in March 1991, and responses to these questions were provided in August 1991. The application was deemed to be complete by the state of Nebraska in December 1991. Completeness of the application in 1991 is significant because this eliminates (for waste generators within the CIC) an additional waste disposal surcharge imposed on waste generated within states that are not satisfactorily progressing in the development of a disposal site. Present plans call for the state to review the responses and provide second round questions in March 1992, with responses to be provided by May 1992. The license is expected to be issued in October 1993; construction is to begin in November 1993; and the facility is to begin operation in 1995.

REFERENCES

1. Nebraska Department of Environmental Control (NDEC) Title 194, "Rules and Regulations for the Disposal of Low-Level Radioactive Waste."
2. *Code of Federal Regulations*, 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste", U.S. Government Printing Office.
3. NRC Regulatory Guide 4.18, "Standard Format of Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste," (June, 1983)
4. U.S. Nuclear Regulatory Commission, NUREG 1199, "Standard Format and Content of a license application for a Low-Level Radioactive Waste Disposal Facility," (Rev 1, January 1988).
5. U.S. Nuclear Regulatory Commission, NUREG/CR 5041, "Recommendations to the NRC for Review Criteria for Alternative Methods of LLRW Disposal, Task 2b: Earth-Mounded Concrete Bunkers (Vol 2)," R. H. Denson, R. C. Bennett, R. M. Wamsley, D. L. Bean, and D. L. Ainsworth, U.S. Army Engineer Waterways Experiment Station (January, 1988).
6. U.S. Nuclear Regulatory Commission, NUREG/CR 4370, "Update of Part 61, Impacts Analysis Methodology," (January, 1986)
7. B. A. NAPIER et al, "GENII- The Hanford Environmental Radiation Dosimetry Software System," PNL-6584, Pacific Northwest Laboratory (December, 1988).
8. U.S. Nuclear Regulatory Commission, NUREG/CR-5387, "Low-Level Waste Shallow Land Disposal Source Term Model: Data Input Guides," T. M. Sullivan and C. J. Suen, Brookhaven National Laboratory (July 1989).