FINAL CLOSURE OF THE CENTRE DE LA MANCHE RADIOACTIVE WASTE DISPOSAL FACILITY

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ABSTRACT

Closure of a near-surface disposal facility, constituting the transition from the operating period to the institutional control period, involves the placement of a cap over the entire disposal area at the end of the operating period.

Three basic design criteria where adopted for the disposal cap. Impermeability, reliability, and protection. To meet these criteria, the design concept calls for the use of multiple layers totalling approximately 4 meters. The disposal facility will be monitored throughout the institutional control period. The long term monitoring program will be based on the existing program for the operating facility and will include special provisions for the cap itself.

INTRODUCTION

The primary performance objective of the radioactive waste disposal facility is to protect the public as well as the environment from potential releases of radioactive materials. To meet this objective, the disposal facility design must effectively isolate the waste. For near-surface disposal facilities, the final cap placed over the disposal units is an important part of the waste isolation system.

The Agence Nationale pour la Gestion des Dechets Radioactifs (ANDRA) has operated the Centre de La Manche Low-Level Radioactive Waste Disposal Facility since 1979. The facility is located near Cherbourg in northwestern France, next to the La Hague reprocessing plant operated by Cogema. The facility receives only short-lived, low- and medium-level radioactive waste. The Centre de la Manche is full, and a new waste disposal facility is under construction in the Aube department, with operations scheduled to begin in early 1992. In addition to this major new project, Andra is arranging for final closure of the Centre de la Manche facility.

Closure of a near-surface disposal facility, constituting the transition from the operating period to the institutional control period, involves the placement of a cap over the entire disposal area at the end of the operating period. Closure activities at the Centre de la Manche disposal facility will be conducted from 1990 to 1995, with the end of the operating period scheduled for 1994. The duration of the institutional control period is presently set at 300 years.

At the Centre de la Manche disposal facility, the waste packages are placed inside engineered structures called "monoliths" or "tumuli". Collection systems for infiltrated water are located at the base of each disposal unit; the systems are connected to an underground network of galleries which drain into a sampling station to the northwest of the site. After sampling and analysis, the water is sent to Cogema's effluent treatment station for processing. The water collection systems are not a part of the disposal cap project and are not discussed in this paper.

DESIGN CRITERIA FOR THE FINAL DISPOSAL CAP

Requirements for radioactive waste isolation imply three main design criteria for the disposal facility's final cap.

Impermeability Criterion

The amount of rainwater penetrating the cap and coming into contact with waste must be extremely low to prevent radionuclide leaching and subsequent migration.

Reliability Criterion

The cap must be impermeable for the duration of the institutional control period. The materials of construction must be selected for their contribution to long-term reliability.

Protection Criterion

In addition to resisting water infiltration, the cap must resist external forces such as erosion, freeze-thaw cycles, water chemistry and living organisms. The disposal cap must be sufficiently thick and made of appropriate materials to protect the disposal units from such external forces.

DESCRIPTION OF THE FINAL DISPOSAL CAP

The final disposal cap at the Centre de la Manche will be constructed in two phases. Phase 1 will be completed in three successive operations scheduled for the 1991 to 1995 time frame. Phase 2 will involve placement of an impermeable layer made up of natural materials over the preliminary disposal cap. Phase 2 will begin only after any settling of the Phase 1 cap has ceased, which may take several decades. In the interim, observation of the Phase I cap may lead to changes in the Phase 2 cap design.

Externally, the disposal cap will look like a roof made of sloped panels. The largest panel will measure 140 x 25 meters. The distance between both lower edges of the roof will be 50 meters. The panels on the outer edge of the disposal unit will be at the same elevation as the top of the waste packages. From the disposal units to the site boundaries, the cap will slope at a 2.3-to-1 incline until it reaches the perimeter road, and at a 1.5-to-I incline below the road.

Multiple-Layer Design Concept

The multiple layers of the disposal cap (Fig. 1), starting from the base of the cap, will be as follows:

- a bottom layer of schist will create the basic slope of the disposal cap, and provide a thick barrier between the waste and the cap;
- a drainage layer made of fine-grain sand will detect the presence of water beneath the bituminous geomembrane;
- a bituminous geomembrane made of a bitumen-saturated geotextile;
- a drainage layer made of fine-grain sand will detect the presence of water beneath the impermeable layer of natural materials (Phase 2 only);
- an impermeable layer made of natural materials (Phase 2 only);
- a drainage layer made of fine-grain sand and local gravel will collect water that penetrates the schist of the biological barrier;
- a semi-impermeable layer of schist will minimize the amount of water that reaches the geomembrane and constitute a biological barrier for the membrane against root systems and burrowing animals; and
- a layer of topsoil to promote grass growth.

The multiple-barrier system will extend to the perimeter road on all sides of the site.

Water Collection System for the Covered Zone

General: Water recovered from the cap will be collected in networks surrounding the site. Surface water will be separated from infiltration water by:

- a system of large pipes for surface water located immediately below the perimeter road; and
- a system of smaller pipes for infiltration water drained from the cap.

Surface Water: Surface water will be collected at the bottom of each curved roof panel. At the end of each double roof panel, the water will be drained off in rainwater channels located at the edge of the disposal cap where it meets the road. The channels will draw off surface water both from the roof and from the slope above the road by a gutter that runs the length of the perimeter road into a 1000 mm drain pipe which receives all surface water.

Infiltration Water: Two drainage systems above and beneath the bituminous geomembrane will collect all infiltration water.

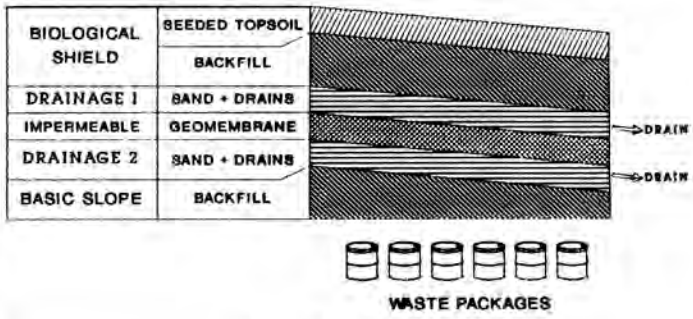
- Upper Drainage System

The upper drainage system will consist of a layer of sand and local gravel in which a drain is placed.

- Lower Drainage System

The lower drainage system will consist of a layer of sand and two drains. This system will allow each half-panel section of the cap to be isolated, which helps to locate the source of a failure of the impermeable layer signaled by abnormally high levels of drainage water. An identical drainage system will be installed between the clay layer and the bituminous geomembrane during Phase 2 operations.

Basic Design Phase I



Basic Design Pase II

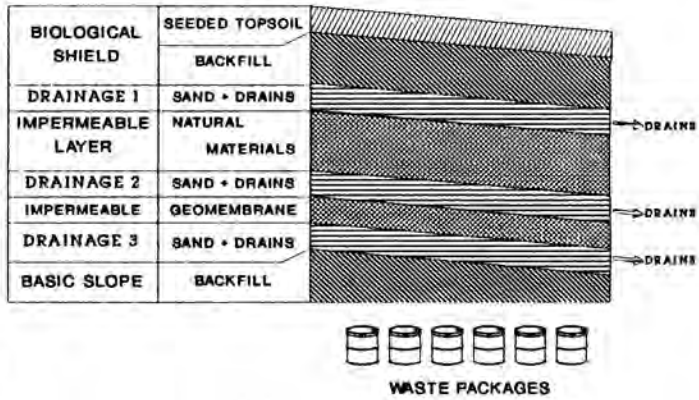


Fig. 1. The Centre de la Manche disposal facility final cap.

- Drainage Surrounding the Covered Zone

The bituminous membrane will be curved upwards at the perimeter of the covered zone to form a watertight gutter; a drain pipe will be placed in the gutter and the gutter will be filled with gravel. A secondary bituminous membrane located underneath the gutter will collect water from the lower sand layer.

At each of the roof's gutters, the drains will be connected to monitoring stations located along the side of the perimeter road. All monitoring stations will be connected by one main drain pipe.

Monitoring Stations: The two surface water collection systems, one on the east side of the final disposal cap and one on the west side, drain northwest into the main monitoring station where there are flow-meters, a collecting basin, radioactivity monitoring equipment, and pH measurement equipment. The monitoring station is connected to a storm basin that regulates the flow of water downstream to the Ste. Héléne stream.

The two drainage water collection systems, also to the east and west of the final disposal cap, will drain northwest into the drainage monitoring station equipped with a flow-meter and connected to the main monitoring station.

Rainwater from the southern part of the site, where administrative services and the public information building are located, and from the road that parallels the Cogema fence, drains into a gutter connected to a monitoring station for site operations equipped with a flow-meter. This monitoring station will be connected to the main monitoring station at the end of the operating period.

The flowrate of rainwater from the final disposal cap will be determined by taking the difference between the flowrates measured in the main monitoring station and the sum of the flowrates from the drainage and operations monitoring stations.

Miscellaneous

A four-meter-wide road around the perimeter of the site will be constructed to facilitate site monitoring and maintenance.

The entire cap will be covered with a layer of topsoil and seeded, and shrubs will be planted on the lower slopes just below the site boundary to minimize maintenance of that area. These measures will enhance the environment while providing maximum security for the site.

Civil Engineering

Retaining Walls: Because the site has a very small surface area, retaining walls with a maximum height of 5.5 meters on the north side and 3.5 meters on the east will be needed. The retaining walls will be heavy, reinforced-concrete structures with shallow foundations built in weathered sandstone. The walls will be relatively thick and therefore will have a minimum amount of rebar.

For esthetic reasons, the lower part of the walls will be covered by a band of masonry. The masonry will extend over a low wall between the north and east walls; an identical wall is planned for the south end of the east wall.

Basin Reinforcement: In the final phase, the reinforced-concrete basins of the underground collection system in the northwest part of the site will be covered by the final disposal cap. The present structure will be covered by a reinforced-concrete support structure designed to withstand the vertical load of the backfill. The reinforced structure will consist of a reinforced-concrete slab supported by reinforced-concrete pillars and walls.

The cleared area above the existing roof of the basins will permit access to the basins and to the galleries of the north and west underground water collection systems for future maintenance operations.

PLACEMENT OF THE DISPOSAL CAP

Because of the stringent requirements for long-term reliability, the highest level of quality must be sought, both for the materials of construction, and for their emplacement. A quality assurance program has been established for the entire project to ensure that the required level of quality is achieved and maintained at all times.

Materials Preparation

Construction materials for which standards exist must conform to those standards. In the absence of specific standards, detailed technical specifications will be developed. All materials must undergo both suitability tests before use and quality control checks during use.

The schist in the backfill will be made up from stockpiles at the site or in its vicinity, and will be sorted to eliminate over-sized pieces. Other materials and prefabricated concrete components will come directly from the quarry or from prequalified mills and plants.

Materials handling during delivery and storage must ensure that the quality of the materials is maintained from fabrication through utilization.

Civil Engineering

Construction of the retaining walls on the east and north of the site will involve site grading, rebar mat placement, concrete formworks, and concrete pouring. After the forms have been removed from the retaining walls, site drainage systems will be constructed and filled with gravel.

The protective support structure over the basins will be built in the same way as the retaining walls, although prefabricated concrete will be used to work around the existing basins. After the concrete foundation and the main walls have been poured, prefabricated pillars and beams will be erected. A reinforced-concrete slab will be poured on top of the beams to stabilize the entire unit, and a waterproof covering will be placed over the slab.

The water collection and monitoring systems (checkpoints and monitoring stations) will be constructed with prefabricated concrete as much as possible, while the foundations and larger pieces will be poured directly in place.

Grading

Several operations will be involved in site grading.

Preparation of Graded Base and Bottom Layer

The central part of the tumulus will be graded to within a specified layer of schist from the existing temporary cover. A 2-to-1 slope will be graded at the perimeter of the disposal units, with the minimum distance of 0.50 meters to the waste packages being maintained at all times.

After grading has been completed, and the base compacted if necessary, the perimeter road will be constructed. The road bed will act as a boundary for the base layer embankment. As the embankment is built up, the base layer for the roof can be prepared with layers of compacted schist. The materials will be regularly analyzed to determine their in situ characteristics.

Sand, Gravel, and Drainage Pipes

After completion of the base layer, which will be leveled off at right angles to each trough at the top of the dam between gutters, the following activities will be conducted:

- the gutters will be dug;
- the reinforcing membrane and its geotextile covering will be laid;
- the lower drains will be laid;
- the lower layer of sand will be put in place and compacted;
- the geomembrane and its reinforcement will be put in place;
- the upper layer of sand will be put in place and compacted;
- the drainage ditch will be dug;
- the upper drainage layer will be put in place;
- the gravel layer will be put in place and compacted; and
- the geotextile will be put in place at the bottom.

Quality control will focus primarily on size grading of the sand and gravel.

The Bituminous Geomembrane

The geomembrane for the gutters will be positioned the length of the gutters, running east-west or west-east.

The principal geomembrane of the cap will be positioned north- to-south in line with the steepest incline of the slopes. The geomembrane's reinforcement will be placed in the same direction as the geomembrane below the gutters.

The slope's geomembranes will be put in place first, and will be left unattached at the top of the slope. The roof geomembranes will be laid over the slope geomembranes, and will not be joined until the embankments around the perimeter of the site are finished.

Quality control will be performed on membrane placement operations, including checks of the condition of the geomembrane or the overlap of the edges. Joints will be inspected by ultrasound or by a vacuum box for individual spots.

Drainage Pipes

Drainage pipes will be inspected for conformance at the plant, especially for the size of drain slits. On-site leak tests of the joints are not planned, as the pipes in question are drainage pipes.

Schist in the Biological Barrier

Except for the first layer of schist in contact with the drainage layers, no particular specifications for schist grade size exist for the biological barrier. Large chunks of schist may actually discourage burrowing animals.

The schist will be laid and compacted in layers. Sand will be added to the top layer to promote evapo-transpiration. All but the top layer will be compacted in the same manner as the base layers of schist; the top layer will be packed more lightly to facilitate root growth of surface vegetation.

Quality control of the schist layer will be identical to quality control of the base layer.

Topsoil

The only special instruction for placement of topsoil is that it need not be packed down. To limit erosion during the first planting months, a mixture of rapid-growth and slow-growth seeds is recommended.

Markings for Photogrammetry

Markings will be laid so that surface movements of the cap, such as subsidence, can be detected by aerial photogrammetry.

CAP MONITORING INSTRUMENTATION

The final disposal cap will be instrumented to monitor overall cap performance, to detect leaks or potential leaks, and to acquire data useful in constructing future cap sections.

Topographical Monitoring

Ground movements caused by subsidence of waste packages are anticipated in the older, northern part of the site. The type and magnitude of ground movements could lead to deterioration of the cap's impermeability and should therefore be constantly monitored.

Markings will be placed on the cap in a grid formation so that ground movements can be detected by aerial photogrammetry. Aerial photographs will be taken frequently enough and filed so as to constitute a chronological record of ground movements. On-site topographical measurements and visual inspections of the surface condition of the cap will also be performed. The topographical data can be analyzed to detect any high-risk areas.

Hydraulic Monitoring

The monitoring stations will be equipped with flowrate meters for surface water and infiltration water, both above and below the geomembrane.

The data acquired from the flowmeters will provide an indication of the performance of the upper layers with respect to run-off water, infiltration water, and evapo-transpiration. The first cap section to be constructed in Phase 1 will be instrumented to monitor interstitial pressures to verify the site water flow model. The monitoring device below the geomembrane will serve as a "first alert" in the event of cap failure.

Drainage Beneath the Disposal Units

The water collected in the underground water collection system will be monitored throughout the institutional control period. Flowrate and activity levels, as well as detailed records on the waste disposal in the units, will provide a total picture of the performance of the cap in combination with the other data acquired in the site monitoring program.