ANDRA'S CENTRE DE L'AUBE: DESIGN, CONSTRUCTION, OPERATION OF A STATE OF THE ART SURFACE DISPOSAL FACILITY FOR LOW AND INTERMEDIATE LEVEL WASTE

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Abstract

The ANDRA's Centre de l'Aube disposal facility for low and intermediate level radioactive waste may be considered as a state-of-the-art repository. Since its implementation in the early nineties, the French facility has been used as a model by many countries worldwide for the surface disposal of radioactive waste. The disposal concept developed by ANDRA, the French Radioactive Waste Management Agency, consists of a multiple-barrier system designed to isolate radioactivity and provide protection to the public and to the environment. Waste operations at ANDRA's Centre de l'Aube are largely automated to ensure better protection to site workers. The paper reviews all aspects of the repository implementation: siting, design, construction, operation and future closure, and environmental monitoring.

1. INTRODUCTION

France's experience in the management of radioactive waste is supported by thirty years of operational activities in the field of surface disposal of low-and intermediate-level waste (LILW). The so-called Centre de l'Aube which started operation in 1992 is a new surface repository for LILW operated by the French Radioactive Waste Management Agency, ANDRA [1]

The Centre de l'Aube took over the so-called Centre de La Manche which was the first surface disposal facility opened in France and operated from 1969 to 1994. The total capacity of Centre de l'Aube is 1,000,000 m^3 of waste and its operating lifetime should exceed 50 years.

2. REGULATORY REQUIREMENTS FOR LILW DISPOSAL

In France, the final disposal of LILW is governed by Fundamental Safety Rules (FSR) which set performance objectives for radwaste repositories both on the short term during operation and on the long term, after closure.

According to these rules, the disposal system must be implemented to protect the general public and the environment and allow reuse of site after a monitoring period of about 300 years. The dose limit has been set at 0.25 mSv per year for the general public.

3. MANAGEMENT POLICY FOR LILW

The management policy in France calls for surface disposal of short-lived LILW. The waste may contain a relatively small quantity of long-lived emitters. More precisely, the mean specific activity for alpha emitters in a surface repository must be less than 0.37 GBq/t (0.01 Ci/t).

LILW has been disposed of at the Centre de la Manche facility from 1969 to 1994. This repository which is shown on Figure 1 ceased operation in June 1994 after receiving 525,000m^3 of waste. Construction of a multiple-layer earthen cap started in 1990 and was completed in 1996. In the near future, the facility will be licensed by the Regulatory Authority to enter the Institutional Control Period. ANDRA will be responsible for the monitoring of site environment during the 300 years of the surveillance period [2].

FIG.1. Aerial view of ANDRA's Centre de la Manche.

FIG. 2. Aerial view of ANDRA's Centre de l'Aube.

A new surface repository known as Centre de l'Aube entered service in January 1992. The disposal site that covers 100 hectares offers a total capacity of 1,000,000 m^3. The facility will be operated for around 50 years. Figure 2 shows an aerial view of Centre de l'Aube.

4. SAFETY — RELATED DESIGN APPROACH

According to the regulatory requirements, the radioactivity in waste packages must be isolated from the public and from the environment through a multiple barrier system composed of :

- Waste conditioned in metallic or concrete containers ;
- Engineered structures, including an impervious cap and a leachate collection system ;
- Site near-surface geological formation.

The waste isolation system must maintain its integrity throughout the operating period (a few decades long) and the institutional monitoring period (approximately three hundred years after operation).

Therefore, the engineered system must be designed and constructed, the waste packages be fabricated and the disposal site be selected to prevent or minimize radionuclide releases as long as the radioactivity remaining in the waste has not decayed down to background levels.

5. SITING

Even if the engineered disposal system is inherently safe in terms of radioactivity containment, the hydrogeological and geochemical characteristics of the near-surface geological formation shall constitute an additional natural barrier for containment in the event of a failure of the first two barriers.

Other site selection criteria include:

- Site stability and low seismicity;
- Impervious substratum;
- Simple hydrogeology easy to model;
- Well identified outlet for surface runoff and ground water;
- No valuable natural resources;
- low density of population.

The Aube site was selected in 1985 after a two year program of geologic, hydrogeologic and geochemical characterization and assessment of several potential sites.

The Aube site fit the hydrogeologic model used for site screening, consisting of a semi-permeable surface formation over an impermeable subsurface, an arrangement which prevents deep infiltration, and with a well identified outlet to facilitate surface water monitoring. In addition, the Aube site is located in a seismically stable region.

6. DESIGN AND CONSTRUCTION

The design developed by ANDRA for Centre de l'Aube provides a sound and durable engineered system consisting of concrete structures ultimately covered after operation by a slab and lined with a waterproof coating. In addition to the disposal modules, the engineered system includes two other components:

- The capping system which provides long-term protection to the modules against rainwater infiltration;
- The leachate collection system to detect and collect any infiltrated water.

To provide protection from groundwater infiltration, the disposal modules are placed in an unsaturated zone well above the highest level of the water table. The module base is an impermeable concrete pad with an integrated drain to allow any infiltrated water to run off by gravity to the water collection system where the presence and activity of water can be monitored.

The disposal modules are also designed and built to withstand earthquakes.

During operation, temporary mobile shelters are used to protect open disposal modules while they are being loaded. Once full, the modules are backfilled, covered and coated with waterproof material that will serve as temporary cover until the final cap is constructed. Figure 3 shows a typical cross section of disposal modules with the mobile shelter.

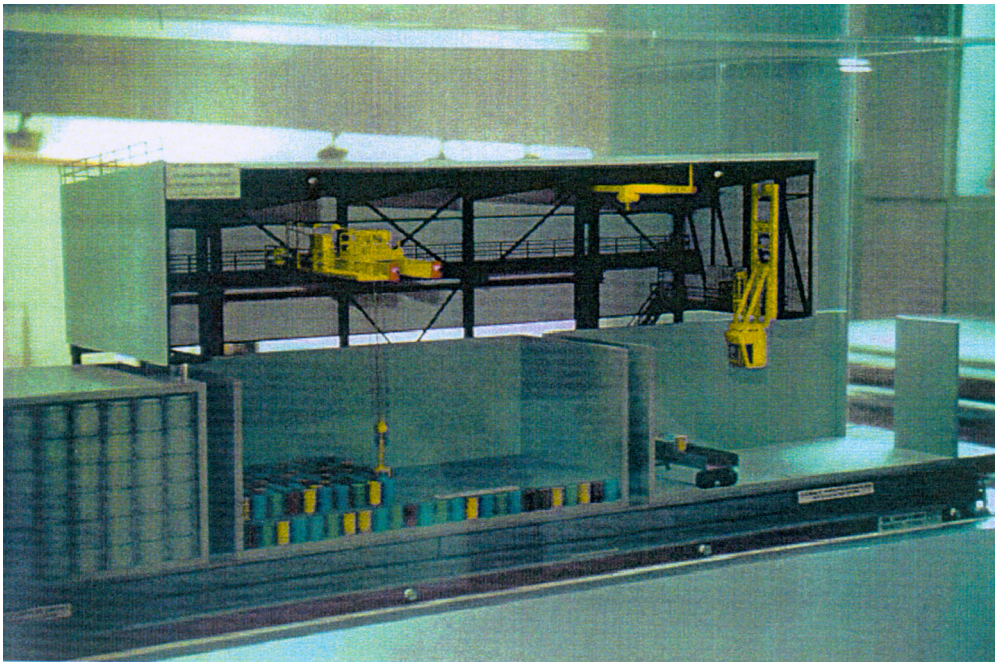

FIG. 3. Typical cross section of disposal modules.

7. OPERATION

7.1. Conditioning and packaging

Any waste delivered to ANDRA's Centre de l'Aube and already conditioned and packaged, is transferred directly to the disposal modules. Different types of waste containers are used by the generators:

- Drums (100, 200, 400 and 800 l);
- Metallic boxes (5 and 10 m^3);
- Cylindrical concrete containers;
- Cubical concrete containers.

Part of the waste shipped to the repository requires additional conditioning and/or packaging. A 1000 t supercompactor is operating on site to compact 200 l drums with a volume reduction factor of over 3. The compacted pellets are placed inside a 400 l steel drum and cement mortar grouting is provided to block the pellets inside the drum.

Some waste delivered to the disposal site in 5 or 10 m^3 containers requires stabilization with a cement matrix. A grouting unit is housed on site in the same building as the supercompactor to grout metallic boxes and concrete containers with cement mortar.

All these operations are either fully automated or remotely controlled.

An interim storage building provides temporary storage for waste that is not suitable for disposal and awaits further conditioning or packaging. This facility is also used on the following occasions:

- When conditioning or handling equipment is not available momentarily,
- In case of litigation on waste shipments or packages.

7.2. Waste tracking

Each waste package is identified by a bar code label that allows follow-up of waste through a computerised tracking system developed by ANDRA. The system links the waste generator, ANDRA's headquarters near Paris and the Centre de l'Aube facility. The system is used by ANDRA to verify compliance of waste packages with acceptance criteria prior to their shipment, to schedule and to track waste shipments, to maintain a detailed and continuously updated inventory of waste packages and radionuclides disposed of at the site.

7.3. Waste package emplacement

Waste packages delivered to the facility are checked upon arrival for integrity, surface contamination and gamma radiation and then routed to one of the disposal modules.

Several modules are operated in parallel. Concrete containers on the one hand, metallic drums or boxes on the other hand are placed in different modules. The main reason for differentiating these waste packages is the nature of backfilling material: gravel to fill the void spaces between concrete containers, concrete is used for metallic containers.

Since waste package dimensions and weights are quite variable, disposal modules are also dedicated to waste packages according to their size and geometry. This segregation contributes to increasing the module filling ratio and consequently to reducing the disposal cost.

The engineered disposal structures consist of 25 × 25 × 8 m high concrete vaults covered by movable shelters and equipped with 3, 10 or 35 t overhead cranes. All waste handling and transfer operations are either fully automated or remotely controlled. Once the waste shipment is delivered to the appropriate module, the operator lifts each waste package with a remote control gripping device operated from a shielded cabin and then switches to automatic mode. The waste package is rotated in front of a bar code scanner which transmits the data to the tracking system. After checking the data, placement is normally authorized and the waste package is then automatically transferred and placed in its pre-determined location inside the disposal module by the crane as shown on Figure 4. The package location is recorded in the central computer system.

Backfilling material, either gravel or concrete, is also placed using remote control devices. Concrete containers are stacked vertically and remaining void spaces are filled once the module is full. On the other hand, metallic containers are placed horizontal layer by layer and concrete is grouted between containers once each layer is complete as shown on Figure 5.

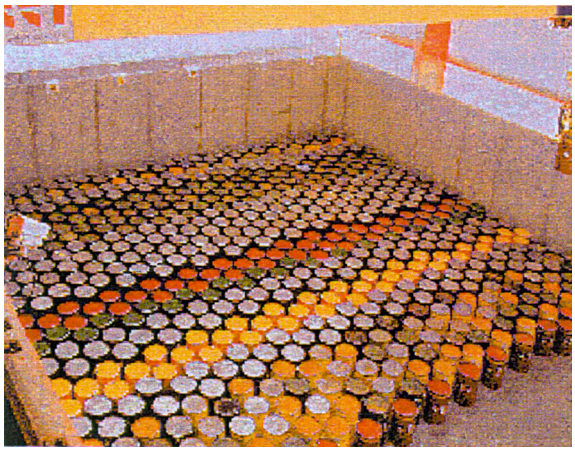

FIG. 4. Waste package emplacement.

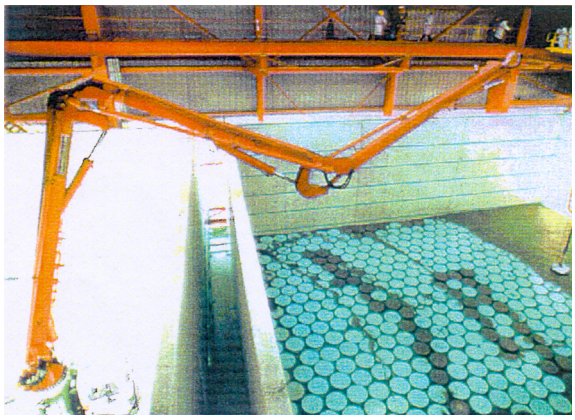

FIG. 5. Concrete grouting of disposal modules.

7.4. Other services

All operations at Centre de l'Aube are performed or monitored from a central control room located in the waste conditioning building. All information regarding the facility operational conditions and safety is also centralised in the control room.

In addition to the waste conditioning building, the interim storage facility and the disposal modules, the Centre de l'Aube site includes the following facilities:

- Administration building;
- Services building (locker rooms, laboratories, infirmary);
- Maintenance workshops and warehouses;
- Water collection and monitoring system (tanks, storm basin, etc.)
- Visitors Center;
- Restaurant;
- Security building;
- Weather station;
- Ancillary facilities (electrical substation, water treatment, fire protection network).

7.5. Waste transportation

Access to the site is provided through a 4 km road. The site is also accessible by rail via a private railway terminal located in the nearby town of Brienne le Château. Approximately, half of the

waste is delivered by rail. Shuttle trucks are used to transfer waste packages from the railway terminal to the disposal facility.

8. CLOSURE AND LONG-TERM MONITORING

The final capping system which is to be constructed at the end of the operating period, will be designed to restrict the flow of water into the disposal modules over the 300 years of the Institutional control period. Throughout this period, the cap must keep its integrity and resist external forces, such as erosion or bio-intrusion caused by animals or vegetation.

The long-term integrity of the waste isolation system is due in large measure to the effectiveness of the final cap placed over the disposal facility at the end of the operating period.

The multiple layer capping system implemented by ANDRA at Centre de la Manche consists of alternating layers of draining and impermeable materials. The hydraulic monitoring system integrated in the cap verifies that the water infiltration rate does not exceed a few liters per m^3 and per year.

After closure, the Centre de l'Aube site environment will be monitored during the 300 years of the institutional control period. As for the Centre de la Manche now, ANDRA will be responsible for site environmental monitoring and will report periodically to the licensing authorities about the repository condition.

According to French regulations, the institutional control period is defined as a period following site operations set aside for radioactive decay of short-and medium-lived radionuclides, during which institutional control is exercised to:

- Monitor for any failure in the containment systems and to prevent to spread of radionuclides which may have adverse effects on the public or on the environment; and
- Prevent intrusions into the site.

The objective of institutional control is to protect the public and the environment for as long as the potential radiological hazard exists. The achievement of this objective is based on maintaining the containment performance of the whole disposal system, in particular the disposal cap and on regulating access to the site. This assurance is gained by monitoring, servicing, and caretaking, as necessary.

The program implemented by ANDRA to monitor the facility containment performance and the site environment focuses on monitoring of engineered systems, in particular the disposal cap and the water collection systems. These activities include visual inspection, topographical survey, aerial survey, hydraulic monitoring as well as rainwater, ground water, air, dust, sediment and vegetation sampling, measurements and analysis.

Ground water is sampled from the drains and pipes constituting the water collection systems within the disposal cap as well as below the disposal structures. Water samples are also taken from drill holes surrounding and within the disposal area. Data collected include alpha, beta tritium, pH, activity levels of various radionuclides, in particular iodine, and concentration levels of several heavy metals.

The off-site environmental monitoring activities are focused on surface water, ground water, river sediments, air, airborne dusts, vegetation and milk sampling and analysis. Groundwater is sampled from drillholes located downstream on water pathways. The same data are collected as for onsite monitoring.

9. CONCLUSION

The first years of operation at ANDRA's Centre de l'Aube demonstrate that low and intermediate level waste can be managed in a safe and cost efficient manner and disposed of on surface, with good public acceptance.

Since its implementation in the late eighties the Centre de l'Aube concept has been used as a model for the surface disposal of radioactive waste in many countries worldwide. This concept has benefited from lessons learnt at the former Centre de la Manche surface repository to ensure ever-growing level of protection to the public and the environment.

REFERENCES

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