Centre de la Manche Disposal Facility after Ten Years of Institutional Control - 15255

Florence ESPIET-SUBERT*, Alain ANDRE*, Albert MARCHIOL**, Denise RICARD***, Catherine DRESSAYRE***, Bruno CAHEN***
Andra, Agence Nationale pour la Gestion des Déchets Radioactifs
* Centre de stockage de la Manche, ZI de Digulleville, 50448 Beaumont-Hague CEDEX – France
** Centre de stockage de l'Aube , BP 7, 10200 SOULAINES-DHUYS - France
***1-7 rue Jean Monnet - 92298 Châtenay-Malabry - France

ABSTRACT

Centre de la Manche disposal facility is the first French surface disposal facility for low and intermediate level short lived radioactive waste. It has been operated for 25 years, from 1969 to 1994. The facility was licensed for the institutional control period in 2003. As there were significant changes in the design of vaults or in waste acceptance criteria during the 25 years of operation, it was decided to implement a capping system including a bituminous membrane that would be able to sustain strains that might be caused by the settlement of waste packages in the eldest parts of the facility, where conditioning modes were different than those as presently practiced.

In 2008 Andra submitted to ASN, the regulatory body in France, a file related to the safety of the facility including a study of the opportunity to modify capping system. Andra's project was to improve long term watertightness and to stabilize the sides of the cover by smoother slopes through a progressive approach. This file was completed in early 2015 by a progress report providing in particular results on studies related to the durability of the bituminous membrane. They take into account periodical measurements performed on samples of the membrane extracted from the capping system and studies performed on the phenomenology of ageing of the membrane. These data support the strategy of improvement of the capping system developed by Andra in order to achieve a more passive surveillance.

INTRODUCTION

Centre de la Manche was the first radioactive waste disposal facility operated in France. Located in the north-western part of the Cotentin Peninsula, between Cherbourg and Cap de La Hague, it was commissioned in 1969 and received waste packages until June 1994. It started to be superseded in 1992 by the *Centre de l'Aube* Disposal Facility in Eastern France. Thus, approximately 1,470,000 waste packages were delivered to the *Centre de la Manche* over a period of 25 years. In the end, about 920,000 packages, totaling 527,000 m^3, were disposed of at the facility.

In 1994 after the delivery of last packages and as capping works of the facility were going on, Andra, the French Radioactive Waste Management Agency, filed an authorization application to enter into the institutional control period, with the relevant supporting safety documentation. This application was submitted to a public inquiry. However the government decided to create in February 1996 a dedicated commission to assess the situation of *Centre de la Manche* and to provide an opinion on its impact. The Commission tabled its conclusions in July 1996 and Andra adapted its application for the facility's institutional control period. Finally the order for the entrance in the institutional control period was issued in January 2003. It required an update of the safety report after 6 years and Andra had to make proposals for an evolution of the capping system in order to ensure "a long term passive safety of the repository". A safety review was performed by the regulatory body (ASN) at the end of 2009.

In accordance with the requirements issued by the regulatory body, Andra had been carrying out its studies on the possible improvements of the capping system and had to prepare a progress report to be submitted to ASN in early 2015. This report includes results of the studies related to the durability of the bituminous membrane that is used to ensure the protection of the repository against rainwater and other topics related to the long term evolution of the facility.

THE OPERATIONAL PERIOD OF CENTRE DE LA MANCHE: A CONTINUOUS IMPROVEMENT

Centre de la Manche currently covers an area of about 15 hectares. Its operation was authorized by an Order signed by the French Prime Minister on 19 June 1969 [1]. Pursuant to the new nuclear legislation implemented in 1973, a first safety report was prepared in 1975. The CEA entrusted the operational responsibility of the facility in 1979 to the new French National Radioactive Waste Management Agency (*Agence Nationale pour la Gestion des Déchets Radioactifs - Andra*) created within the CEA. Andra became an independent agency by the 30th December 1991Act.

Figure 1: general view of the facility during operation

The Order of 19 June 1969, creating the facility, referred to the maximum permitted concentration in drinking water (MPC) to define the disposal modes, water being the main contamination vector. Low level waste in drums may be disposed in the ground provided that it is covered by a plastic and bitumen protection and that a drainage system is implemented at the bottom of the disposal cell. Beyond 1,000 MPC (threshold between low and intermediate level waste), waste contained in drums and products in bulk had to be disposed of in concrete cells before being grouted with liquid concrete. The waste could also be disposed of directly in the ground provided it was packaged properly (*i.e.*, in cement blocks or in cemented drums) against any risk of water leaching.

Direct disposal in the ground was quickly abandoned. 3 trenches were built but 2 of them only were operated and the wastes were removed from the third one. They were replaced by concrete disposal cells in the ground.


Figure 2: concrete disposal cells

In 1984 Basic Safety Rule RFS I.2 [2] was issued by the regulatory body. It expressed safety principles for the design of a near surface repository. According to this rule containment of the radioactivity during the operational period and an institutional control period should rely on two engineered barriers: the waste package and the disposal system. After the institutional control period, the duration of which should not exceed 300 years, safety should only rely on the limitation of the radioactive content of the disposal facility, in particular for long lived emitters, and on the properties of the site. As a complement, Basic Safety Rule RFS III.2e [3] imposed systematic waste packaging and established minimal characteristics, particularly with regard to containment, with which packages must comply depending on the nature and activity of the waste. A minimum mechanical strength was required in order to integrate packages in the disposal architecture.

Disposal structures were including a steel reinforced concrete bottom slab that provides resistance to the burden of the disposed waste packages. This slab was also intended to provide watertightness in order to prevent infiltration of effluents in the water table. Furthermore water going inside the disposal vault has to be considered as an effluent and had to be segregated from rain water. Therefore a dedicated collecting system was implemented between 1979 and 1982 in an underground monitoring gallery. Collected water was transferred to the treatment station of the reprocessing plant nearby *Centre de la Manche*.


Figure 3: disposal vaults

Figure 4: implementation of the monitoring gallery

As there have been significant changes in the design of vaults or waste packages conditioning modes during the operation time of *Centre de la Manche*, it was decided to implement a capping system. This capping system should be able to sustain strains that might be caused by settlement of waste packages in the eldest parts of the facility, where packages did not meet acceptance criteria derived from the Basic Safety Rule RFS III.2e. Therefore a bituminous membrane was selected. Such a membrane, about 6 mm thick, has good water tightness properties (significantly less than the target of a few liters per square meter and per year). Its maximum strain before failure under a tensile stress is 45 to 50%.

The "roof" of the capping system is made of successive tilted sectors of 25 meters with slopes between 6 and 14% above the repository. Because of the limited area of the facility, the slopes on the side are steeper (about 25°). Different layers are implemented. In particular they include permeable levels under and above the membrane and coarse material to protect the membrane against intrusion by animals or roots. Infiltrated water above and under the membrane can be collected by drains and can be monitored.

MATERIAL	FUNCTION
Top soil	Evaporation
Coarse material (clayey sandstone)	Bio-intrusion barrier
Fine material (sand w/drains)	Drainage
Bituminous geomembrane	Watertightness
Fine material (Sand w/drains)	Drainage
Coarse material (clayey sandstone)	Support and slope

Figure 5: cross section of the capping system

Capping works started in 1991. Andra made an application to enter the institutional control period that was submitted for a public inquiry. Moreover the government decided to create a dedicated commission to assess the situation of the facility, the so-called "Turpin Commission" [4]. This commission investigated some topics as the radioactive content of the facility, the impact of the facility on the environment, the strategy of management of the facility. The commission recommended that the capping system has to be modified in order to provide a safe containment, even in case of an interruption of the institutional control.

Figure 6: general view of the facility after closure

THE INSTITUTIONAL CONTROL PERIOD OF CENTRE DE LA MANCHE

The purpose of the institutional control period is:

- To investigate the behavior of the different components of the facility, in particular the capping system. If necessary some remediation or improvement can be performed.
- To check the impact of the facility and to compare it to the impact that is predicted in the safety report.

This control is performed by a limited staff of 5 people that remains on *Centre de la Manche* , with the support of the teams of Andra's headquarter and of Centre de l'Aube. The results of the surveillance are published yearly on the Internet site of Andra (www.andra.fr) after a presentation to the local information commission.

Surveillance of the Capping System

The surveillance of the capping system includes the monitoring of the mechanical stability of the capping system and the monitoring of its efficiency to protect against infiltration of rainwater.

Mechanical stability

The surveillance of surface movements is made by periodic topographic measurements. These measurements have indeed shown settlements on the "roof" in some places. In one place a maximum displacement of 50 cm since 1997 was detected.

It was therefore decided to investigate and to repair this sector of the capping system. Works were performed in October and November 2009. The different layers of soil were removed and the bituminous membrane could be observed. Observations showed that membrane had elongated without damage along the ground deformation. The initial geometry of the capping system has been restored.

Figure 7: remediation works on the “roof” of the capping system

Other displacements were measured on the slopes of the capping system that correspond to a slide of the covering material along the membrane. These movements were continuous with a velocity of 1 or 1.5 cm per year (3.5 cm per year in one sector). To prevent a landslide in the areas most affected by these movements, walls were implemented and the slope was softened at the base of slope, supported by the wall.

Figure 8: reinforcement of the slope of the capping system

After a period of observation of the effects of these remediation works, it is planned to suppress the walls and to soften the slopes on the entire circumference of the repository. This will need an expansion of the area of the repository and will be gradually made as the land surrounding the facility will be available.

Efficiency of the capping system against infiltration by rainwater

Measurements since the beginning of capping works show that the collected volume and activity of water from the vaults have significantly decreased (see table 1).

Effluents collected from vaults	**1991**	**2013**
Volume	21,000 m^3	450 m^3
Beta activity (but ^3H)	1.3 GBq	0.003 GBq
^3H activity	1,700 GBq	2.4 GBq
Alpha activity	0.4 GBq	0.0007 GBq

Table 1: Variations of effluents collected by vaults

This volume includes infiltrations that do not percolate through the vaults and the membrane but through connecting pipes at the boundaries if the capping system. They make the major part of infiltrated water and a dedicated system was implemented in 2011 in order to separate them. In 2013, 436 m^3 from the 450 m^3 were collected in this dedicated system.

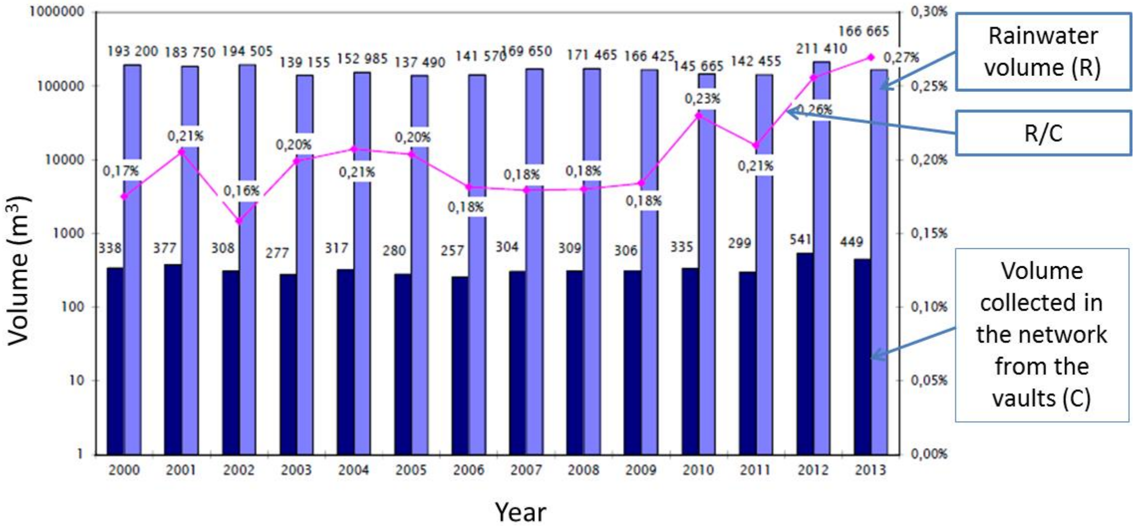

Figure 9: rainwater and effluents collected from the vaults network

Andra also measures water volumes that are collected in the drainage under the membrane. The volume is low (see figure 10), in the range of a few tens of cubic-meters. However it was observed degradation in 2013 after some reinforcement works on the capping system. This degradation is due to the detachment of the membrane from the concrete drainage chambers where it is connected. Then water collected in the drainage above the membrane can partially flow inside the drain under the membrane, which distorts measurements.

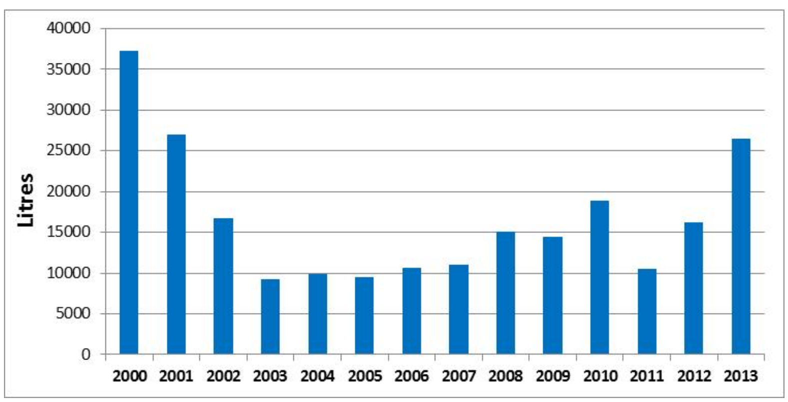

Figure 10: water collected under the membrane

Despite these defects it is possible to conclude that the overall infiltrated water volume under the membrane remains under a few litres per square meter and per year. However there is a necessity to modify the collecting systems in order to suppress disturbing effects.

In addition diagnostics of the membrane by periodical samplings are performed every five to ten years. Tests are performed on the membrane (thickness, mechanical strength, water tightness), on the bitumen (softening temperature, chemical content) and on welded areas (mechanical strength). These samples are also used to assess the durability of the membrane. Comparisons are made with samples that are stored in a shelter or samples of new membrane (just manufactured).

As the permeability of the membrane is very low, the diffusion coefficient of water through the membrane is used to characterize its watertightness. Experiments are performed with tritiated water HTO.

Measurements show an increase of the diffusion coefficient just after the emplacement of the membrane; afterwards, no indication of significant ageing can be detected (see figure 11).

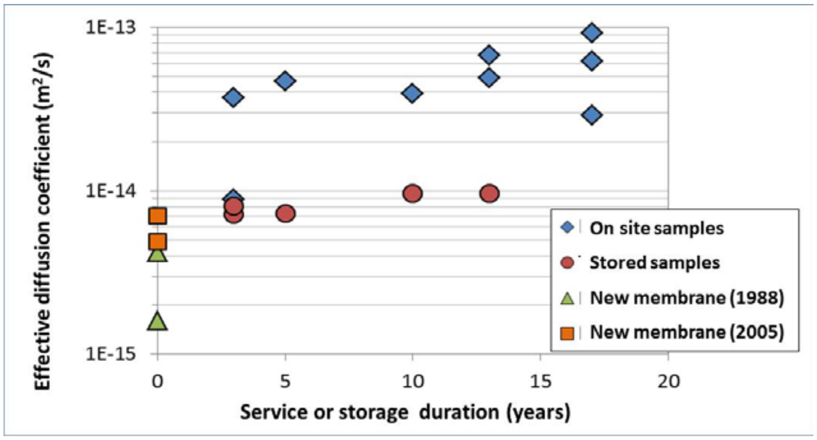

Figure 11: measurement of diffusion coefficient of water through the membrane

Additional measurements were performed on samples from the remediated area on the roof of the capping system. These samples were submitted to an accelerated oxidation (60°C for 3.5 months) and to leaching (1 month). No change in the diffusion coefficient was observed.

The diffusion coefficient would correspond to a water flow through the membrane in the range of 0.3 litres per square meter and per year. Measurements show the membrane is able to provide long term watertightness. Monitoring on samples will be carried on to confirm the stability of its properties.

In addition a program of qualification of a complementary watertightness with a mixture of bentonite and local material has been undertaken. This complementary watertightness, which is not considered as necessary by Andra, could be implemented when the capping system is mechanically completely stabilized.

Environmental Monitoring and the Impact of the Facility

Chemical and radiological measurements are performed in order to check that the facility complies with the applicable regulation, in particular in terms of discharge. Measurements are also made in the water networks, in rivers, in the sea, in the ground water, in vegetation and in the air.

In particular groundwater is monitored by 73 boreholes drilled around the facility and its vicinity, in particular to follow up tritium contamination. Tritium is the only radionuclide that can be detected in groundwater in the environment of the facility. The average tritium activity at the boundaries of the facility is being decaying (14,000 Bq/l in 1996– 3,300 Bq/l in 2013), even if very locally boreholes the level of activity remains significant (maximum: 110,000 Bq/l).

The activity in the river, which has its source close to the facility, is 50 Bq/l and about 420 Bq/l in the source of a contributory stream. In this stream the decay started in 2000, due to the propagation of the tritium plume in the groundwater.

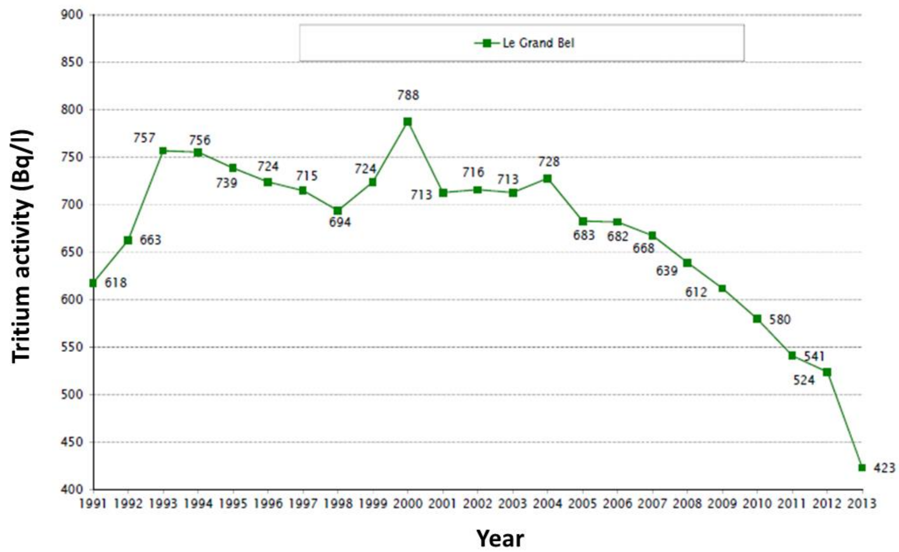

Figure 12: evolution of tritium concentration with time at the source of a river close to the facility

The present impact on a theoretical critical group living along the river can be calculated, taking into account pessimistic assumption on his way of living. It is less than 0.3 µSv per year in 2013. It shows there is no need of intervention on the disposal facility; the contamination by tritium should naturally decay.

CONCLUSION

According to the Order of January 2003 that pointed out issues to be dealt with the objective to achieve a passive long term safety, Andra proposed options to gradually improve the capping system and to check the relevance of the proposed options by observation periods. The safety review in 2009 confirmed that the facility was safe and approved the principles of the phased approach to modify the capping system and requested additional technical information. Additional information was brought by Andra in early 2015 to support this strategy.

Through local softening of the slopes, improvement works have been performed from 2009 to 2013, according to the proposed strategy. The efficiency of these improvement works will be now checked for a period of about 10 years before new improvement works. Present results appear already satisfactory.

Monitoring of the facility has also been carried on and confirmed the overall efficiency of the capping system in term of watertightness. It has also shown some weak points of the design of the capping system:

- The bituminous membrane actually protects waste packages against rain water infiltration but its extension is not large enough. It does not cover the connecting pipes from the vaults to the underground monitoring gallery. As a consequence “parasite” infiltrations occur and disturb measurements of water flows. These “parasite” infiltrations provide the most important part of collected water in the network that is fed from the disposal vaults.
- The connections of the bituminous membrane with the concrete chambers does not seem robust enough. Some of them were probably damaged during the civil engineering works to soften the slopes. Therefore a part of collected water above the membrane flows under the membrane at the level of the chamber. It makes also a disturbance to assess the overall efficiency of the membrane.

To assess the durability of the membrane, Andra made periodic measurements of the characteristics of the membrane on in situ samples. These measurements show indeed a stability of properties. Furthermore studies were performed on the ageing mechanisms of the membrane; they show that it would be possible to rely on watertightness properties for the whole duration of the institutional control period. Nevertheless Andra will carry on periodical measurements on samples of the membrane and prepare a complementary technical option with watertightness with clay if needed.

The technical data obtained since the last safety review in 2009 confirms the proposed strategy for the phased approach of improvement of the capping system. The periodic safety reviews are also part of a dynamic process through which the monitoring of this facility will become progressively more and more passive, even if its initial design does not fit with the present rules that are used for the French near surface disposal facilities.

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