Very Low Level Waste Disposal in France: The Industrial Issues- 11554

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ABSTRACT

The very low level waste disposal facility of Morvilliers was built in order to provide a long term solution to accommodate waste with a very low activity in the specific French regulatory framework. According to French nuclear regulation, waste generated in nuclear facilities may not be free released considering the level of activity. A waste zoning has to be implemented to segregate zones in which wastes are, may be or may have been contaminated or activated- so called nuclear waste- and zones where no contamination or activation is possible- so called conventional waste-. Therefore ANDRA was in charge of siting and designing a safe and cost effective disposal facility. The design was based on the regulation for conventional hazardous waste repositories: trenches in a clay layer. The facility was located near the village of Morvilliers, in the vicinity of Centre de l'Aube disposal facility, that is dedicated to low and intermediate short lived waste. It started up in October 2003. Its capacity is 650,000 m^3 for 30 years of operation.

The design flow for deliveries was initially 25,000 m^3 of waste packages per year. But, due to a lower density than initially expected and due to a lack of experience of waste zoning for decommissioning works, Andra had to adjust the design of the facility in order to increase its capabilities; Andra can presently offer a service for annual deliveries of 35,000 m^3.

However to prevent an anticipated saturation of the disposal facility, efforts for nuclear waste minimization must be done. They include in particular an optimization of waste zoning in facilities. Considering the significant contribution of metallic waste to forecast inventory of the facility, the feasibility and the opportunity to recycle a part of metallic nuclear waste are investigated.

THE VLL DISPOAL FACILITY OF MORVILLIERS

The implementation in France of a disposal facility dedicated to very low level waste is a consequence of French regulation related to waste management in nuclear facilities. Every French nuclear facility must establish a *waste zoning* with a view to segregate any sector where waste is actually or likely to be contaminated or activated (nuclear waste zone) from all other sectors where there is no waste-contamination or activation risk (conventional waste zone).

Figure 1 : principles for waste zoning

As a consequence a large part of these waste are just potentially radioactive. Therefore a condition for the development of the repository for very low level waste was not only a satisfactory level of safety but also the cost effectiveness of the solution to be implemented.

Figure 2 : Morvilliers VLL disposal facility

The design of the repository complies with general regulation for hazardous waste repositories. Containment relies on the properties of a near surface clay layer in which the disposal structures are built. Waste is disposed of on a plastic impermeable membrane settled in large trenches excavated in the clay layer. Emplacement is carried out under mobile roof to protect against rainwater. Waste is usually transported in packages to prevent dispersion of radioactivity during emplacement operation. Trenches are filled with sand, and then covered by a plastic membrane and a clay layer.

Andra selected a suitable site in the village of Morvilliers, Aube Prefecture, close to the *Centre de l'Aube* disposal facility dedicated to low and intermediate level short lived waste, thus allowing for synergies between both facilities. An area of 45 ha was surveyed where a clay layer varying between 15 and 25 m in thickness was identified.

The whole area of the disposal facility is 45 ha for a capacity of 650,000 m^3. It was planned initially for 30 years of operation with a design flow for deliveries of 25,000 m^3 of waste

packages per year. After operation, an institutional monitoring period should not be longer than 30 years.

Waste packaging requirements were established to standardise as much as possible handling equipment. However as handling techniques are rustic due to very low dose rates, any type of container may be studied for waste conditioning.

Figure 3: implementation of the capping system

In current operation when a disposal cell is filled, it is covered with a HDPE membrane. Then the mobile roof can be removed and located above the next cell to be constructed. Operation is performed in another cell during these construction works. Therefore two mobile roofs are required. The initial sizes of the disposal cells were 80 m long by 25 m wide by 6 m deep.

The facility can provide conditioning services as compaction, solidification or stabilisation for hazardous waste.

SEVEN YEARS OF OPERATION

First packages were delivered in October 2003. Very quickly it appeared that the density of waste was lower than initially forecast and that needs in terms of annual deliveries were over the design flow, mostly due to a lack of experience of waste zoning in particular for decommissioning works. Waste generators asked Andra to increase its capabilities.

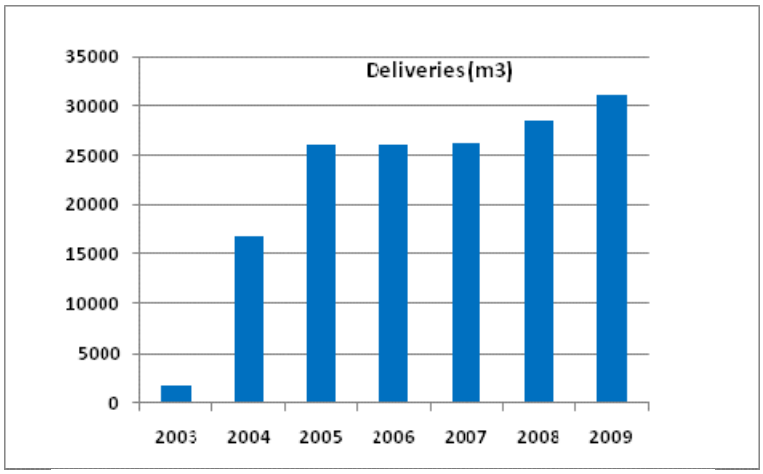

Figure 4: waste deliveries to Morvilliers facility

This was enabled by an optimization of the design of the disposal cells, making them deeper end longer with steeper internal slopes. So the length of the cells was doubled and Andra could offer an annual deliveries flow of 35,000 m^3 since 2009.

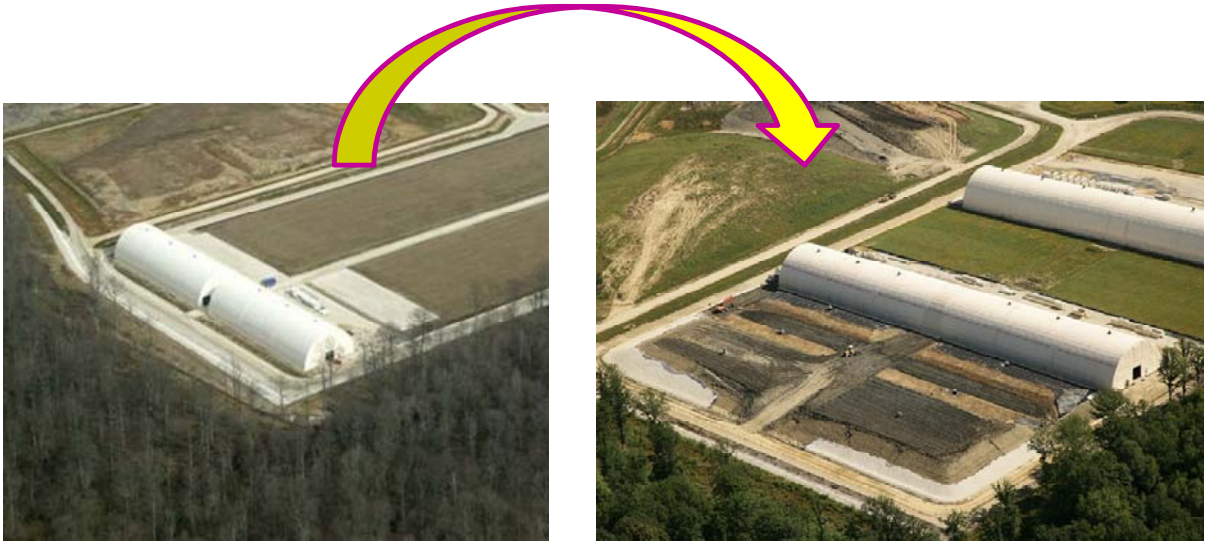

Figure 5: optmization of disposal cells in order to enable an increase of deliveries

However these improvements of the disposal facility will not be sufficient in order to accommodate the actual flow of waste. Andra issued in 2009 an update of the National Inventory of radioactive Waste in France. This update shows that the average annual flow could climb up to 40,000 m^3 between 2010 and 2020 and decrease to 24,000 m^3 per year after 2020. Nevertheless the overall forecast till 2030 is 850,000 m^3 and remains quite above the capacity of Morvilliers disposal facility.

Therefore in the framework of the French Radioactive Waste Management Plan Andra and waste generators were requested to study means in order to have a more efficient use of the disposal resource:

- By improving density of waste,
- By assessing the feasibility and the opportunity of developing, within the French particular regulatory framework, recycling routes for very low level nuclear waste.

Figure 6: disposal cell with sand backfilling

Parallel efforts are being made to improve the density of waste, including a better use of compaction tools of the disposal facility.

Recycling is investigated for concrete scraps. In particular Andra is assessing the feasibility of replacing the sand that is used to backfill the disposal cells by crushed concrete.

Metallic waste represent nearly 50% of the forecast inventory for Morvilliers. The relevance of disposal of large quantities of such waste is questionnable, especially when these waste are

just potentially contaminated or activated and could be easily decontaminated. The re-use of these metals would save valuable disposal volumes while meeting sustainable development goals.

RECYCLING METALLIC NUCLEAR WASTE IN FRANCE

The collection of metallic radioactive waste for a purpose of melting and partial recycling is already practiced in different countries (United Kingdom, USA, Germany, Sweden…). The metal can be re-used to make containers for radioactive waste or shieldings (Siemplelkamp in Germany). When the level of activity meets the levels for free release, it can be mixed with other sources of metal and be used outise the nuclear industry (Studsvik in Sweden).

In France the plant of Socodei/Centraco has melted since 1999 about 20,000 tons of low level waste. Melting significantly reduce the volume to be disposed of (by a factor of about 10). Futrhermore it enables a “decategorization” from the low level class to the very low level class through decontamination obtained through melting. A part of the metal is recycled as shielding liners in waste packages.

A recycling route has been developed in France for lead by the French Atomic Energy Agency, in cooperation with non nuclear industrial companies. A specificity of this route is that lead is first melted in a nuclear workshop inside Marcoule nuclear plant. The obtained decontamination allows a sufficient “cleaning level” that permits a subsequent remelting and manufacturing in a non nuclear facility without any radiological hazard. Traceability of materials is ensured. The recycled products are shieldings for the nuclear facilities.

<u>The French framework for metallic waste recycling</u>

The transposition of principles for waste zoning leads to search for routes ensuring the traceability of materials during processing and reuse. As their release is excluded, these materials cannot normally benefit directly from the recycling infrastructure of conventional metallurgical industry.

The quantity of nuclear metallic waste is estimated at approximatly 400,000 tons over 30 years, i.e. about 13,000 tons per year. It has to be compared to the ferrous scraps that are collected each year in France whis is between 10 and 15 millions tons. This “scaling factor” of 1,000 has consequences on economical conditions through which nuclear metallic waste recycling would be performed.

Figure 7: metallic waste at Morvilliers facility

Figure 8: metallic waste package at Centre de l'Aube disposal facility (LIL-SL)

The nuclear metallic waste have heterogeneous natures (different metals and different qualities of metal...). In some cases there are very homogeneous batches; for example, the dismantling of Eurodif plan should generate about 130,000 tons of steel with a unique quality. Each investigated recycling route, including treatment of contaminated metals, fabrication of pieces, has to take into account the specificity of the incorporated metallic waste.

Moreover radionuclides that are present in the waste have various chemical characteristics. They will have different behaviours during the melting process. For steel some components as Cobalt 60 or Nickel isotopes are mostly soluble in the molten metal. Others as actinides, uranium or plutonium isotopes will be found mainly in the slag, others as antimonium or Caesium will be found in ashes.

Then at the present step two processing routes can be investigated:

- A processing route that will be completely located within the nuclear industry, as it is performed at Socodei/Centraco facility. Traveability is ensured. This route seems to be suited for batches contaminated by radionuclides that are soluble inside the molten metal. However depending on the pieces to be made with the recycled metal, new dedicated equipments might be necessary within the nuclear industry for their manufacture.

- For waste which can be effectively decontaminated through melting, it is possible to study the feasibility of manufacture in dedicated workshops inside non nuclear industry without any radiological constraint, as it is already performed for lead. However the level of required traceability has to be assessed for materials and secondary waste.
  This route seems to be relevant for specific types of contamination, for facilities that processed uranium for instance. The know how of non nuclear industry can be mobilized.

The principles of waste zoning should also require that the use of recycled products is done inside the nuclear installations in areas classified as "nuclear waste" to avoid the transformation of sectors that are presently "conventional waste zones " in sectors of "nuclear waste". Or will these recycled products make their own areas of nuclear waste inside areas with conventional waste. This can restrict the opportunities for reuse.

A working group with waste generators and Andra

According to the French Radioactive Waste Management Plan (2010-2012) these investigations are performed within a working group with French main generators (EDF, AREVA, CEA) and Andra.

The work will be based on the components made with recycled metal that can be considered, including the chronology of potential re-use. Due to the limitations mentioned above, the components of disposal facilities, for instance waste packages, are interesting items to be explored, if necessary with the development of new designs for waste packages. Other equipment of nuclear facilities, even construction materials such as concrete steel reinforcement bars, could be considered. Such reuse must be assessed with regards to the availability of the metallic waste with a very low activity, quantitatively and qualitatively. The qualitative aspect refers first to metallurgical grades, and secondly to the radionuclides which are present and which are a driver for the industrial tools to be implemented.

Figure 9: disposal vaults under construction at Centre de l'Aube disposal facility (LIL-SL)

The implications of traceability requirements on the industrial tools should be examined. For example, assuming fabrication in a conventional facility, what should be the status of scraps or lubrication or cooling liquids that have been in contact with the recycled metal?

Similarly the constraints of using recycled metal components must be identified. As an illustration the use of recycled metal containers could, in some cases, lead to classify as nuclear waste zone areas for transit or storage of such containers. This would ultimately have a negative effect on the quantities of very low-level waste to manage.

Therefore a dialogue with the Nuclear Safety Authority will be required to formalize a doctrine on these questions.

To compare with the disposal option, recycling has to be assessed in terms of environmental impact. It includes in particular dosimetric cost of concerned activities (cutting the metallic waste, sorting, melting, manufacturing new pieces, disposal activities…), with a consideration to the long term radiological impact of the waste in the repository. Discharges, secondary waste, transportation must also be considered.

But the implementation of a recycling route should have an economical relevance. It can be assessed through a comparison of the manufacture of pieces with "conventional" metals. It

should take into account savings in disposal costs and the expansion of the duration of operation for the repository. Therefore an economical model has to be established in order to examine the opportunity of recycling.

CONCLUSION

There is stringent to need to optimize the use if disposal capacities. In this regard the disposal of metallic waste with a very low radioactivity, sometimes just a potential radioactivity, may not be consistent with a sustainable development policy. But recycling of nuclear metallic waste in France has to be performed within a regulatory framework that induces particular constraints on both the reusability as on methods for the manufacture of recycled parts. The working group, including EDF, CEA, AREVA and Andra's, plans to identify technical, regulatory, societal and economic factors that determine the feasibility and viability of recycling of contaminated scrap metal.

The importance of the issue was perceived by the French public authorities who have not only included this issue in the work program of the National Radioactive Waste Management Plan but also signed an agreement in August 2010 with Andra under the "investment program of future ". Part of funding allocated to Andra is intended to support the development of recycling industries by promoting and supporting industry initiatives, together with waste producers and with potential users of recycled products. Optimizing the use of the volume of repositories is a clear objective. The criteria for selection of beneficiaries also include the technical and economic benefits (employment, return to the rule ...), the business plan with the anticipated return on investment, as well as the effect on the industrial branch through association of several public and private partners on projects.