Radioactive Waste Management in France: Taking-Up Present and Future Challenges – 15120

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ABSTRACT

The reduction of the volume and radiotoxicity of radioactive waste has been one of the key drivers for the implementation of the French nuclear program. Interactions between the nuclear industry, the administration, the competent authorities and other stakeholders including the civil society has led to a continuous evolution of the industrial facilities, practices, solutions and products to move towards waste minimization.

Bringing a solution to the management of ultimate radioactive waste is clearly a requirement for the sustainable development of nuclear energy whose crucial role in the world's future energy mix has been confirmed in the past few months by several international organizations.

The first question to be answered concerns the definition of radioactive waste. This notion may be seen as self-evident. It is not. For example, used fuel is considered a High Level Waste in Finland or Sweden, but a recyclable material in countries including China, France, India, Japan, Russia, and the Netherlands. In France, a definition is provided by law to clarify this notion. Indeed, the 2006 French law concerning the Sustainable Management of Radioactive Materials and Waste stipulates that "ultimate radioactive waste shall include any radioactive waste for which no further processing is possible under current technical and economic conditions, notably by extracting their recoverable fraction or by reducing their polluting or hazardous character". Used fuel is thus reprocessed in order to reduce the final waste volume and long term radiotoxicity, while extracting value from the recovered materials.

Even if the general approach and the processes may be common for waste management, it is important to clearly make the distinction between the wastes stemming from used fuel processing or conditioning (when considered as waste), the wastes generated through the operation of nuclear power plants and fuel cycle facilities, and the waste arising from the dismantling of nuclear installations.

After a brief overview of the different types of waste stemming from nuclear power generation, this paper will review solutions and processes already implemented for their safe and efficient management. It will also practically illustrate the evolution of these processes and related facilities to further gain in efficiency, notably in terms of volume reduction; the related R&D outcomes will be addressed. It will also describe the upcoming challenges in this field and the envisioned solutions to respond to them; the efficiency, the completeness and consistency of these solutions with the currently considered global framework, based on a stepwise and long term approach from waste generation to disposal, will also be analyzed.

INTRODUCTION

AREVA has been designing and implementing solutions for permanently improving existing waste management routes and mitigating risks, with safety being the top priority. Innovation is also at the heart of waste management solutions and routes under development. Backed by 40 years of experience in this field, the proposed solutions offer significant benefits including:

- A drastic reduction of Utilities' final waste volume and long term radiotoxicity, compared to direct disposal thanks to the "Universal Canister" (UC) strategy. The UC strategy based on a single type of standardized package for High Level Wastes (HLW) and Intermediate Level Long Lived Wastes (ILLLW) rationalizes the Utilities waste management from reception, handling and storage of waste to the transport to final repositories. The related costs are therefore optimized.
- A drastic reduction of the ultimate waste volume stemming from plant operations,
- A significant impact on the repository footprint reduction especially for HLW and ILLLW through the implementation of processes including advanced characterization, decontamination, incineration, compaction and vitrification. This constitutes an additional contribution to overall cost reduction and also allows minimizing cost uncertainties. Thus, it allows operators to refine the assessment of the back-end provisions.
- An increased proliferation resistance.
- An enhanced public acceptance; in France, the Executive and the Parliament have been placing more and more emphasis on enlisting additional stakeholders, the General Public in particular, in the debate over solutions for radioactive waste management; the organization in 2013 of a public debate on the project to create a deep disposal facility for radioactive waste in the French districts of Meuse and Haute-Marne, referred to as the "Cigéo project", is an outcome of this policy.

40 Years of Regulatory Framework Consolidation

For decades, France has been strengthening regulation in the field of waste management. The related general regulatory framework was put in place by the Law of July 15, 1975 aimed at promoting the prevention, recycling and transformation of all kind of waste. The first PWR reactor was commissioned quite at the same time, in 1977. A National Radioactive Waste Management Agency (ANDRA) was established in 1979 within the French Atomic Commission (CEA). The first law dedicated to radioactive waste management was enacted in 1991 leading two years later to the modification of ANDRA status as an independent public body. This law was revised and supplemented by the Planning Act of 28 June 2006 concerning the Sustainable Management of Radioactive Materials and Waste. Backed up by a 15 year research program launched by the 1991 law, the Planning Act sets out a roadmap based on a stepwise approach with clear prescriptions.

From that time on, clear definitions have been provided distinguishing radioactive substances from materials and ultimate waste. Ultimate radioactive waste is for example defined as radioactive waste which can no longer be processed under the technical and economic conditions of the moment, notably by extraction of its reusable part. Pursuant to the law, the inventory and location of all radioactive materials and waste present in France is established, updated and published every three years. The Act also stipulates that "the reduction of the quantity and harmfulness of radioactive waste is sought, particularly through used fuel treatment and the processing and packaging of radioactive waste". Thus, the used fuel is not considered a waste in France, while it is the case notably in Sweden or Finland. It also pushes forward the research program on complementary areas including partitioning and transmutation, waste disposal and storage. The financing principles and frameworks as well as the related control means are also specified. As an outcome of the 2006 parliamentary works, France's Parliament chose deep disposal as the appropriate solution for ensuring the long-term safety of radioactive wastes and lightening the burden on future generations.

The National Radioactive Materials and Waste Management Plan “PNGMDR” is the backbone of the 2006 Act [1]. All types of radioactive waste and materials are considered in a consistent framework. The plan aims notably at:

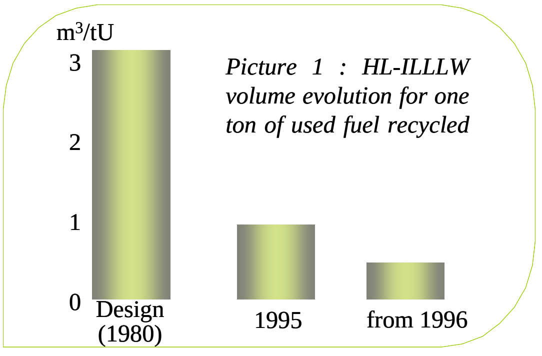
- taking stock of and assessing the existing management solutions and routes for radioactive materials and waste,
- making an inventory on foreseeable needs in terms of storage and waste disposal and indicating the necessary capacities for such installations and the storage duration,
- setting objectives for the radioactive wastes for which a definitive management route does not yet exist.

This PNGMDR is elaborated by a pluralistic working group including French nuclear operators, AREVA, CEA and EDF, along with ANDRA and NGOs. It is led by the Ministry of Ecology, Sustainable Development and Energy, and the French Nuclear Safety Authority. The strengthened involvement of the civil society reflects a shared will to improve democracy and transparency for the development and implementation of solutions impacting numerous stakeholders. Thus, the “PNGMDR” is for the French operators a privileged tool for optimizing the management routes, the required processes equipments and facilities including repositories.

The stronger level of interactions between the nuclear industry, the administration, the competent authorities and other stakeholders including the civil society has led to a continuous evolution of the industrial facilities, practices, solutions and products to move towards waste minimization, as illustrated in the following chapters. Paradoxically, the involvement, in the PNGMDR process, of anti-nuclear organizations has led to an increased dissemination of information to the general public leading thus to a better knowledge of nuclear energy and related challenges and solutions.

Making the Best of 40 Years of Experience in Radioactive Waste Management

Waste minimization has been a key driver for the design of fuel cycle facilities and for their evolution. As an example, Picture 1 illustrates how the process evolutions at La Hague Recycling Plant have led to a six fold reduction of the HLW and ILLLW volume. Such evolutions will be described later on.



Picture 1 : HL-ILLLW volume evolution for one ton of used fuel recycled

Waste minimization has been also sought in the design of nuclear plants. For example, the EPR™ reactor has been designed in such a way to reduce waste production and allow for better waste management. In reducing the production of long-lived radioactive waste by 15%, the EPR™ reactor helps shrink the environmental footprint.

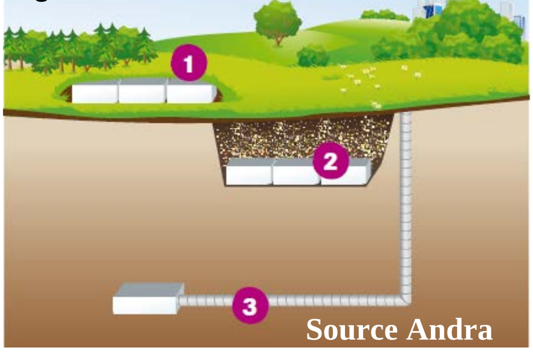
Waste management proceeds during the operating life of the installation through concern for limitation of the volume of waste produced, of its radiotoxicity and harmfulness. It ends up with waste elimination (recycling and/or final disposal) via the stages of characterization, sorting, treatment, packaging, storage, transport and final disposal.

Along with their minimization, one of the major challenges is to ensure that every waste generated has or will have a final disposal solution. For over forty years, France has opted for industrial repositories as a safe and sustainable waste management solution. The principle of disposal consists in isolating the waste from people and the environment for very long periods of time. Many other countries have chosen to set up a long-term solution based on disposal.

In France, there are 5 waste categories, classified according to their disposal solution. The classification is mainly based on the two following parameters: the level of radioactivity and the half-life resulting to the following categories : very-low-level waste (VLLW), low- and intermediate-level short-lived waste (LILW-SL), low-level long-lived waste (LLW-LL), intermediate-level long-lived waste (ILW-LL), high-level waste (HLW).

Three types of repository (Figure 2) are implemented or envisaged in France to take over all French nuclear waste regardless of the level of radioactivity or the lifetime [2]: surface repositories ❶, shallow repositories ❷ and deep repositories ❸ (under design). Industrial repositories already exist in France providing definitive solutions for VLLW and LILW-SL. 90% of the total volume of radioactive waste generated each year in France is disposed of at actual facilities.

Figure 2



The first repository was commissioned in 1969. It is in post-closure monitoring phase since 2003. This 40 years experience allows leveraging on the feedback for the implementation of other repositories. Two projects are under way for providing solutions for LLW-LL and ILW-LL & HLW. The commissioning of the deep geological repository for high and medium level wastes, referred to as “Cigéo”, is expected by 2025.

There is currently not in France a radionuclide activity or concentration threshold below which waste from a nuclear facility would be allowed to be sent to a non-nuclear facility. This is in particular the case for buildings and site after decommissioning for which there is no release criterion. The related wastes representing significant volumes have to be conditioned and eliminated in specific repositories; they are mainly intended to VLLW disposal facilities. Taking into account the scarcity of disposal resources, the introduction of a clearance threshold would allow the treatment and recycling all or part of such waste. Allowing their recycling in the conventional fields would contribute to strengthen the economic interest of such a management route. As an example the dismantling of the AREVA Georges Besse enrichment plant is expected to generate some 150,000 tons of steel, with alpha contamination. Their “recyclability” is currently under study.

The long term management of radioactive substances, one of the most important of which being used fuel, lies in defining the best compromise between reduction at source – potential treatment (including characterization, sorting, processing) - recycling – storage and disposal.

Along with safety which remains the top priority, other parameters including the scarcity of repositories thus their costs, the availability of efficient processes and technologies, the ratio "cost of treatment (in its most general sense) versus cost of repositories" are part of the global equation enabling to select the routes connecting the NPPs, the fuel cycle facilities and the repositories (Figure 3).

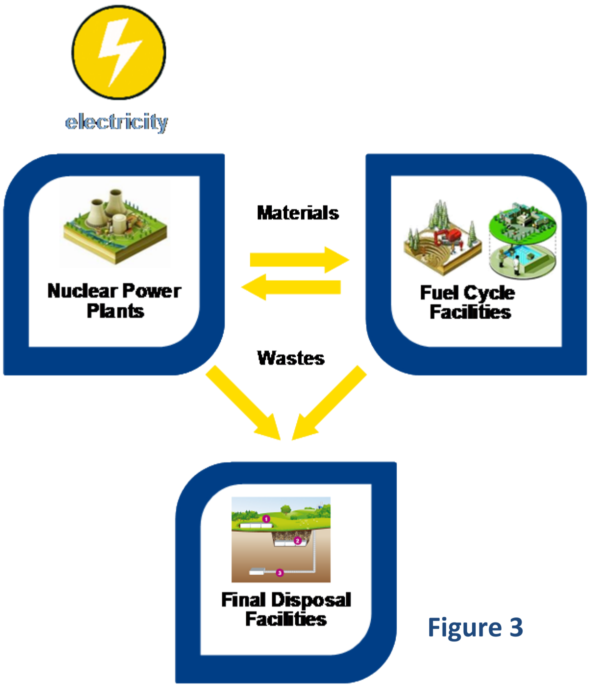


Figure 3

The broad range of solutions implemented and proposed by AREVA for the safe management of radioactive materials and waste allow striking the right balance between these parameters, and thus specifying what could be the most appropriate status for all managed substances. The proposed solutions also contribute to optimize the distribution of waste between management solutions routes. The emergence of new solutions can lead to an adjustment of waste management in existing solutions, allowing a waste to be accepted in a less costly management route that it was initially intended for.

The disposal cost being incremental with the depth of repositories, the reduction of the volume and the harmfulness is a major driver in the development of a global solution based on elementary blocks notably for high and intermediate level wastes. Used fuel recycling is one of these blocks ensuring consistency of the overall optimized management solution supporting the need to preserve scarce disposal resources. Indeed the scarcity of such resources lies in the complexity in their implementation interconnecting technological, ecological, economical and societal challenges.

Minimizing the Overall Environmental Footprint through Used Fuel Recycling

AREVA has implemented recycling capabilities associated with an optimized ultimate waste management with the so-called "Universal Canister" (UC) Strategy. This strategy based on recycling and waste conditioning standardization by using a single type of package for long lived waste, leads to important savings in terms of volume (up to 5 compared to direct disposal) and long term radiotoxicity (up to 10 compared to direct disposal). This ultimate waste consists mainly in fission products and minor actinides traces, as well as structural assembly parts. The fission products are incorporated into a stable borosilicate glass matrix and conditioned in the UC-V (Universal Canister for Vitrified waste, cf. Figure 4) ensuring stability and containment during a very long period (over than 100 000 years). The structural assembly parts - hulls and end pieces – are compacted and conditioned in UC-C (Universal Canister for Compacted waste). Typically, the recycling of one ton of used fuel leads to approximately one UC-V and one UC-C. One of the challenges is to further reduce the ratio

UC/tHM taken into account the used fuel evolution including the increase in Burn-up.

The UC strategy provides the ability to rationalize the global waste management from reception and storage of waste to final disposal. On-site handling, transport operations, and geological disposal selection, design and construction are indeed facilitated thanks to the uniqueness of packaging with smaller volumes and reduced thermal constraints. The resulting costs are therefore lowered.

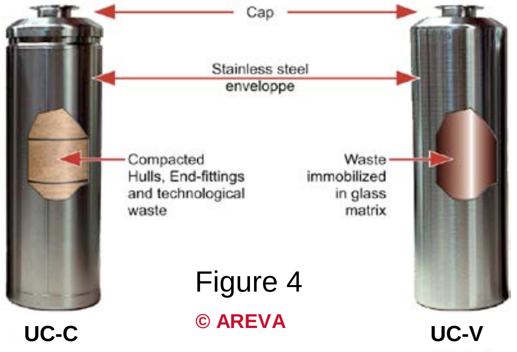


Figure 4

The UCs do not contain IAEA safeguarded materials avoiding safeguards to be implemented for storage and repository. This feature consolidates safety features regarding notably criticality and contributes to further enhance proliferation resistance.

In addition, this strategy is suitable for a progressive implementation of final disposal through a safe and simplified interim storage. Indeed, the related interim storage facilities are currently licensed for about 100 years. This duration is fully consistent with the operation of the deep geological repository which should last, in the French case, over 100 years. The storage duration is also an important parameter in the minimization of the repository footprint, taking into account the decrease in thermal power of vitrified residues.

The UC strategy complements the recycling strategy in an economically sound way [3]. Solving the waste issue has become the prime contributor to nuclear program sustainability: recycling with practical and already visible steps in the minimization of the nuclear legacy to the future generations through the UC strategy contributes to making the final waste issue solvable.

Then, optimization of available raw materials and final waste management are primary imperatives for the nuclear community, particularly when the used nuclear fuel inventory reaches a significant level. 200 000 tons of LWR used fuel are currently stored. Recycling the inventory of such an inventory would allow the demand for electricity from European households to be covered for 50 years. Shouldn't they be recycled, they would represent a much higher volume of waste to be disposed of.

In the French case, the geological repository should have a footprint of around 15 km² [4] taking into account that the whole used fuel inventory would be recycled. The shift in the policy from recycling to direct disposal would lead to a significant increase in the volume of HLW to be stored (90 000 m^3 instead of 10 000 m^3) [4] and thus to a significant increase in the repository footprint (25 km^2).

Minimizing the Waste from Fuel Cycle Facilities and their Environmental Footprint

Along with used fuel recycling dealt with in the previous chapters, AREVA's range of nuclear activities covers the entire fuel cycle from mining, extraction, conversion, enrichment, manufacture and recycling, to logistics and storage services. The development of all these activities has been anchored in a policy for the systematic reduction of volumes and harmfulness of the waste based upon the following general principles [1]:

- preventing and reducing the volume and harmfulness of the waste at the source,

- implementing treatment solutions with the emphasis on reuse, recycling, elimination,
- organizing shipments in a way that minimizes waste volumes and distances shipped,
- implement waste management that does not cause harm to the environment or to public health,
- informing the public of the potential environmental impacts or health effects from waste production and management.

Concrete examples of the implementation of such principles are illustrated for AREVA's main nuclear activities.

Redevelopment and Environmental Monitoring of Former Uranium Mines in France

Uranium was mined at 210 sites in France scattered all over the country. Although fewer than half of these sites were operated by AREVA and its subsidiaries, the French government chose AREVA for the redevelopment and monitoring of all the sites. The physical and chemical treatment of the ores to selectively extract the uranium and precipitate it in the form of a solid, stable compound often (yellow cake) led to production of waste rocks and tailings with levels of radioactivity comparable to that of VLLW. These residues, which are listed in the French National Inventory [5], were disposed of using specific techniques on or near the former mining production sites. The plants in which these operations were carried out have all been closed down and dismantled. Mine redevelopment is an industrial operation in its own right and shall be conducted on solid scientific and technical grounds in adherence to regulation. This mission requires indeed a real know-how and expertise in the field of natural uranium and also commitment to consensus building to respond to the expectations and questions of the different concerned stakeholders. Site rehabilitation seeks to ensure public health and safety, minimize the impacts of residual legacy operations, limit the use of space by legacy sites and ensure that they harmonize with the landscape. The latest PNGMDR [1] underlines the efforts devoted by AREVA for acquiring knowledge needed to assess the stability of the retention embankments around the treatment residue disposal sites and to define new associated requirement levels. The devoted efforts led also to an improved knowledge concerning modeling of radon for scenarios involving the construction of housing on the disposal site and, more generally, confirming the pertinence of the assessments made for following modeling, by comparing its results with surveillance measurements.

Materialization of Final Solutions for Waste Stemming from Front-End Activities

AREVA front end activities combines operations related to uranium conversion and enrichment as well as fuel fabrication. The previously mentioned principles notably based reduction at source, zoning, sorting enhanced characterization, treatment apply to minimize the waste that are generated during the front-end facilities operations. The front-end facilities produce low level or very-low-level uranium-contaminated radioactive operating waste. The related contamination level is generally low enough for the waste to be compatible with and approved for acceptance at the operating LILW-SL and VLLW disposal facilities. It is usually conditioned in drums or dedicated packagings.

The efficiency of the related management routes is demonstrated with a significant increase in the percentage of AREVA's LILW-SL and VLLW transferred to disposal, which already reaches the quasi-totality of the inventory of the related conditioned wastes (for all activities).

Significant Waste Reduction of Waste Stemming from Recycling Operation

The operation of La Hague recycling plant leads to the generation of:

- Universal Canisters (UC-V and UC-C) belonging to AREVA's customers; in the French case they are dedicated to the "Cigéo" deep geological repository to be commissioned by 2025. For foreign customers, these ultimate wastes are sent back to the countries of origin.
- Waste resulting from the plant operation.

40 years of improvements in waste management rules, principles and processes at La Hague plant has led to impressive reduction of the waste volumes.

This good record firmly enshrines in a continuous improvement initiative which aims to limit the liquid and gaseous releases of the recycling plants**.** Since the commissioning of the first facilities in 1966, the impact of releases from the La Hague plant has been reduced fivefold, while the amount of used fuel recycled has significantly increased over the past 30 years. The resulting radiological impact of the site is thus 100 times lower than the average natural radioactivity levels in France.

The outcome is synthesized in the following simplified flowchart (Figure 5) which will be commented hereafter through illustrative examples.

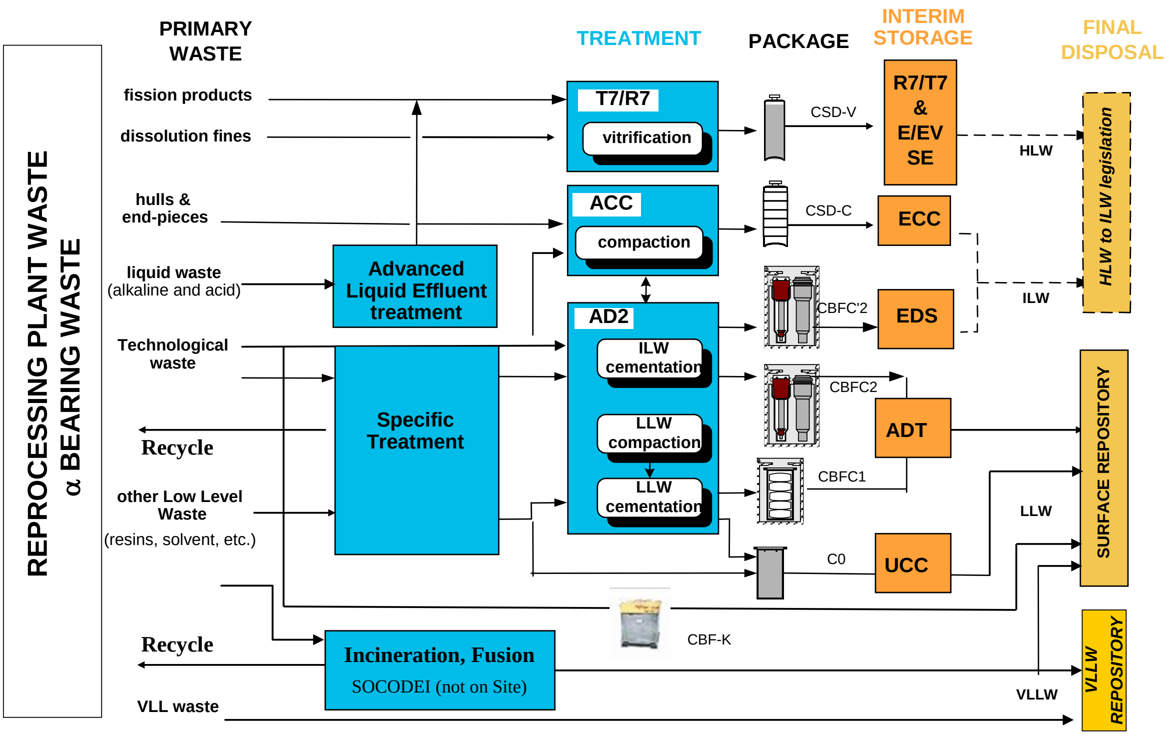


Figure 5

The "Zero Waste" Target

The best waste being the waste that hasn't been produced, the efficiency in the reduction or even the elimination of waste at source has been significantly improved through the implementation of simple rules, for example:

- only bring equipment that is strictly necessary for the operations into the installation: avoid packaging, restrict consumables,
- seek substitution products which produce less waste.

Waste Zoning

The implementation of a waste zoning policy has been contributing to the optimization of the overall waste management scheme. This policy consists in dividing facilities into zones generating nuclear (or radioactive) waste and zones generating conventional waste. This is all the most important that there is in France no release from regulatory controls of materials from zones generating nuclear waste. Zoning was not implemented at the time when the first facilities at La Hague plant such as UP2-400 were operated. The implementation of such a policy for La Hague UP2-800 and UP3 plants has led to a significant reduction of the overall radioactive waste volume per tons of used fuel recycled balanced with an increase in conventional waste volumes.

Process Evolutions

Significant milestones in the waste management optimization have been also achieved through innovation and the implementation of new processes as illustrated with the next examples.

⇨ *Minimization of intermediate-level long-lived waste (ILW-LL)*

The hulls and end pieces were conditioned until 1995 in grout (Cf. Figure 6). In order to optimize the final packaging of such waste, a new facility referred to as "ACC" the French acronym for Compaction Facility, was designed and constructed at the La Hague site. The facility which started operation in 2002 allows a 5 fold reduction of the volume compared to the previous conditioning.

Figure 6

This improvement clearly benefit to Utilities having opted for the recycling of their used fuel.

⇨ *Minimization of La Hague plant technological waste*

The solid wastes mainly consisting of gloves, work clothes, toolings, and parts originating from operation and routine maintenance in La Hague workshops or stemming from the current dismantling of the UP2-400 plant.

Depending on their nature and activity, they are intended either to the existing surface repositories (VLLW and LILW-SL) or the upcoming Cigéo repository for HL –ILLL waste. The trend for the management of these technological wastes has been generally towards compaction when possible associated with cementation.

– Solid Technological Waste Management Intended for Cigéo

The solid technological waste consists of operational waste (tools, failed equipment, filters...) coming from the most contaminated parts of the facilities. Prior to packaging, they are decontaminated, sorted and preconditioned in the facilities of origin or in specific centralized facilities.

They are then dispatched to the centralized solid waste processing facility referred to as “AD2” on the La Hague site where the waste is conditioned in fiber-concrete containers. The conditioning includes the following main steps: reception, interim storage, weighing measurement of activity, deposition in the containers, concreting. The resulting packaging is referred to as CBF-C’2 (Cf. Figure 7).

The volume of solid technological waste intended to the deep geological repository which was at the design stage assessed to approximately 1,8 m^3 per ton treated has been drastically reduced especially since 1990 the start-up of the UP3 plant at La Hague. The good record results from the experience gained in maintenance and repairs and as a result of the equipment reliability. Further minimization has been achieved, through the use of various technologies, such as plutonium decontamination of solid waste, compaction and development of equipment repair techniques.

Figure 8 : Universal Canister of compacted technological waste

An additional gain is thus sought through compaction of the technological waste whenever possible leading to their conditioning into UC-C (Cf. Figure 8)

- *Solid Technological Waste Management Intended for surface repositories*

The management of low activity and short lived waste has also considerably evolved as shown during the operational ramp-up of La Hague plants (Cf. Figure 9).

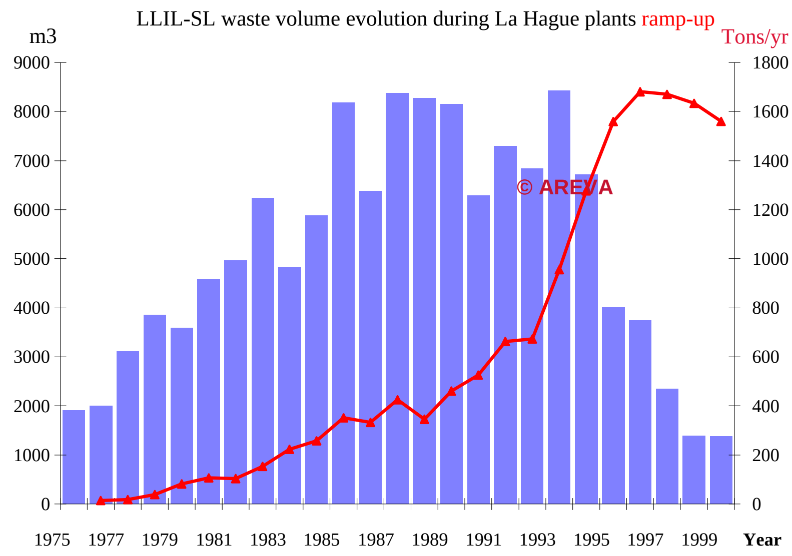
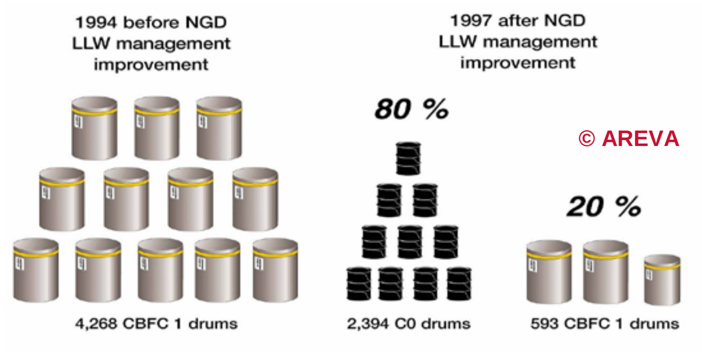


Figure 9

Originally, all the low-level and short-lived solid technological wastes intended for surface repository were conditioned in “CBFC-1” fiber-concrete containers with performances similar to those of the previously mentioned “CBFC-2” containers. However, the waste disposal specifications for LILW-SL introduced a distinction between the lower activity waste which must only be mechanically stabilized and the more active waste for which stabilization and radionuclide containment are required. Based on the operational feedback acquired during the first years of operation of the UP3 and UP2-800 plants in the 90’s, it appeared that the activity of the waste was lower than expected, it was decided to take advantage of the situation by sorting the waste according to their activity and, after compaction, conditioning the lower activity waste by grouting in "C0" stainless steel drums for stabilization, the use of the more expensive CBFC-1s being reserved for the waste requiring radionuclide containment. The related activity levels are described in [6]. Conditioning in C0 packages whenever possible allows thus reducing the overall final disposal cost. Approximately 80% of technological wastes have been conditioned into C0 packages, 20% into CBFC-1. This implies among others optimized characterization tools and methods.

The significant reduction of the waste volume resulting from the implementation of this management policy referred to as "NGD" the French acronym for "New Management of Waste" is illustrated in Figure 10.

Figure 10



⇨ *Reducing ultimate waste through an optimized management of liquid waste*

Initially, the effluents stemming from La Hague plants operation were treated by co-precipitation and the resulting sludges were encapsulated in bitumen and poured into stainless-steel drums. The levels of performance and efficiency reached by the main treatment process have made it possible to considerably reduce the volume and activity of the liquid wastes to treat. AREVA has implemented since 1995, an optimized management of the liquid wastes based on their increased recycling within the process while sending materials with residual activity to vitrification plants in order to be incorporated into standard containers of vitrified residues (UC-B). This milestone marked the progressive abandonment of bitumization.

Maximizing safety, minimizing the overall environmental impact (in particular the final disposal footprint), increasing the operational efficiency in wastes and materials management and thus reducing the related costs remain the drivers for upcoming challenges.

Tacking-up the Current and Upcoming Challenges with Innovation

This paper has illustrated with selected examples the significant reduction of the overall waste volume achieved, based on 40 years of operational experience. The good records underpinning their safe and efficient management are the outcome of permanent evolution of AREVA's operational sites, plants and related processes. They also result from a sustained optimization of the AREVA waste management policies in close interaction with the evolution of the French legal and regulatory frameworks, which has clearly favored these good records. The result is that the very large majority of the waste already generated or that will be generated with the existing facilities benefits from a final disposal solution based on existing or planned repositories.

R&D and innovation have always been and shall remain a cornerstone in the management of waste. The cold crucible melter for vitrification of high-level radioactive waste commissioned in 2010 is a case in point. Indeed, one of the current challenges is to process a broader range of waste such as the effluents originating from the shutdown operations of facilities such as UP2-

400 at La Hague. The challenge also consists in taking into account the evolutions in the compositions of fission product solutions originating from a broader range of used fuel.

Resulting from 25 years of R&D in close cooperation with the French research organization CEA, the cold crucible melter allows waste to be vitrified at very high temperatures over 1200 °C, compared to a maximum of 1100 °C with the hot crucible melter accommodating the vitrification facilities. The cold technology increases the lifespan of the crucible, allows for doubling the output of the La Hague plant, and can vitrify both a wider range of waste materials and more corrosive waste. It allows for example the conditioning of the UMo fission products from the processing of the first fuel from the graphite-moderated gas-cooled reactors at the La Hague site, with highly corrosive features due to the significant level of molybdenum. The lifetime of the cold crucible is 10 times longer than that of the melting pots because its cold structure is not sensitive to corrosion, protected by the layer of solidified glass formed between the structure and the glass bath. This clearly results in the minimization of technological waste.

Some wastes do not currently enter in any of the existing or projected final management routes because of special physical or chemical characteristics. Designing and implementing a dedicated processing/conditioning is part of the challenge. They currently represent less than 0,3% of the total French waste inventory (all French operators). This is for example the case of spent oils and solvents for which AREVA is currently assessing solutions.

Specific efforts are also made by AREVA in association with the CEA in developing solution for conditioning technological waste with an alpha-prevailing spectrum of organic materials; these waste result notably from the operation of the AREVA La Hague and Melox plants. Similar waste is still being produced. Fusion – Incineration – Vitrification are the processes considered in the related R&D program.

The reduction of the waste management is a permanent challenge keeping safety as the top priority. Some of the wastes stemming from AREVA’s activities are at the border of two management routes. AREVA is thus devoting efforts to allow the “decategorization” of the packaging from a disposal solution to a less costly one.

The “decategorization” of CBF-C2 packagings from deep disposal to surface storage by implementation, for example, of advanced decontamination and characterization is another example of a the permanent will to optimize the final disposal solutions and thus minimize the related cost.

Further Increasing Public Acceptance

AREVA has for long put efforts in developing a global acceptance policy based on information, explanation, integration and dialogue at the local or national levels and this for all covered activities. Expectations from the general public are particularly high when it comes to the management of radioactive materials and wastes. Such expectations may turn into fears if not met. For example concerns rose around the La Hague recycling plant regarding the performed activities, the materials and wastes processed and their impact. In order to relieve these concerns, AREVA decided notably to let people see in, by the mean of webcams providing live pictures from the major operations along with pedagogic tools. This clearly contributed to enhance public knowledge about used fuel recycling and waste conditioning. For security reasons, the cameras were shut down pursuant to governmental decisions just after the 9/11 events. Efforts have been pursued or redirected using other tools and means, notably with AREVA's participation in local information committees.

As also developed in this paper the involvement, in the PNGMDR process, of anti-nuclear organizations has led to an increased dissemination of information to the general public leading thus to a better knowledge of nuclear energy and related challenges and solutions.

The French Executive and the Parliament have also been placing more and more emphasis on enlisting public stakeholders in the debate over solutions to used fuel and radioactive waste management. A public debate took place for example in 2005 prior to the enactment of the 2006 Law on this issue. Pursuant to this Law, the submission of any application to create a deep geological repository for final waste shall be preceded by a public debate. Such a public debate has started in May 2013. Even if disruption caused by opponents in attendance prevented some of the scheduled public meetings from being held under correct conditions, a true dialogue has been nevertheless established by the mean of a dedicated website [7] with a significant number of contributions (over 500 Q&A, 300 statements, 60 papers from various stakeholders…) and 9 live contradictory debates on various themes including waste inventory, recycling, transport, reversibility, cost and financing, governance and risk management.

This debate should remain an important step in strengthening the global acceptance of the nuclear program in France. Early 2014, ANDRA submitted proposals in response to the Public Debate in order to take into consideration the related conclusions when finalizing the project.

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