

**“TN International AND ITS OPERATIONAL FEEDBACK REGARDING THE
DECOMMISSIONING OF OBSOLETE CASKS DEDICATED TO THE
TRANSPORT AND/OR STORAGE OF NUCLEAR RAW MATERIALS, FUEL
AND USED FUEL”**

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ABSTRACT :

Within the AREVA group, TN International is a major actor regarding the design of casks and transportation for the nuclear cycle. In the early 2005, TN International has started the project of decommissioning some of its own equipment and was hence the first company ever in the AREVA Group to implement this new approach. In order to do so, TN International has based this project by taking into account the AREVA Sustainable Development Charter, the French regulatory framework, the ANDRA (Agence Nationale pour la Gestion des Déchets Radioactifs – National Agency for the radioactive waste management) requirements and has deployed a step by step methodology such as radiological characterization following a logical route. The aim was to define a standardized process with optimized solutions regarding the diversity of the cask's fleet.

As a general matter, decommissioning of nuclear casks is a brand new field as the nuclear field is more familiar with the dismantling of nuclear facilities and/or nuclear power plant. Nevertheless existing workshops, maintenance facilities, measurements equipments and techniques have been exploited and adapted by TN International in order to turn an ambitious project into a permanent and cost-effective activity.

The decommissioning of the nuclear casks implemented by TN International regarding its own needs and the French regulatory framework is formalized by several processes and is materialized for instance by the final disposal of casks as they are or in ISO container packed with cut-off casks and big bags filled with crushed internal cask equipments, etc...

The first part of this paper aims to describe the history of the project that started with a specific environmental analysis which took into account the values of AREVA as regards the Sustainable Development principles that were at the time and are still a topic of current concern in the world. The second part will deal with the definition, the design and the implementation of the decommissioning processes and the applied techniques.

The third part will present a two years operational feedback.

The last part will introduce new processes which are currently under investigation and will put into light that decommissioning of nuclear casks is a continuous activity that is in perpetual mutation.

DECOMMISSIONING OF CASKS: A BRAND NEW ACTIVITY THAT STARTED WITH A SPECIFIC ENVIRONMENTAL ANALYSIS

For more than 40 years, TN international, which is part of the Business Unit Logistics within the AREVA Group, has designed and manufactured several thousands of nuclear casks that were and are still used for the transportation and storage of nuclear materials. In addition with its own assets, TN International has in 2001 inherited the complete nuclear cask fleet from previous COGEMA. Today, this fleet consists of more than 150 different concepts of casks and is quantified as around 4500 units. In 2002, TN international has performed and consolidated a physical inventory that stressed that more than 2000 casks are obsolete and most of them are in an advance damaged state. Taking into account environmental considerations, health, safety, regulatory and financial issues, TN International has decided to implement a specific environmental analysis that represents for the company the basement of the decommissioning activity. This analysis was aimed in the first place to orientate the strategy of TN International regarding the decommissioning of casks and should now be extended to all associated equipments.

As a general matter, the main goals are:

- to comply with the AREVA policy in terms of environmental and sustainable development values,
- To develop new skills and businesses within TN International (decommissioning of casks, recycling, integration of decommissioning feedback in the design of future casks).

This environmental analysis is structured as follows:

- Regulatory & regulations analysis,
- Technical analysis of the global fleet,
- Generic qualitative environmental impacts analysis (waste management, consumption of natural resources and effluents...),
- Disassembling feasibility analysis,
- Decommissioning processes: Investigation upon existing techniques and methodologies,
- Responsibility and perimeter.

The main conclusions of these analyses have implied the deployment of industrial targeted and adapted solutions for the treatment of wastes that are generated during the decommissioning processes. These conclusions are as follow.

1. Regulatory and regulation analysis

From the regulation analysis, the main issue is the non appliance in France of the free release threshold. Without free release principle, all radioactive substances must be disposed, recycled or reused in nuclear field. Thus, the only existing issue for TN International decommissioning process wastes is final disposal at ANDRA storage facilities. ANDRA is a national organization created by the French government to oversee French laws and regulations. Its mission is to guarantee the protection of the population and the environment against radiological risks potentially caused by the long-term storage of radioactive waste.

Regarding French regulations, the owner of waste is responsible for its treatment and disposal. The main goals that must be taken into account by French industrials as regard as nuclear waste management and hence that must be applied by TN International as regard as its own nuclear wastes are:

- To reduce the amount of non-conditioning nuclear waste
- To ensure, when it is possible, recycling or elimination of waste

Technical analysis of the global fleet and environmental impacts analysis

TN International has first studied materials used in each cask to be dismantled and has performed an impact study regarding these materials, table 1. The aim was to take into account risks associated with decommissioning operations. If these risks occur and are not handled carefully, such operations can lead to dramatic accidents for the safety of the workforce (radiological exposure), the integrity of the plant, and the preservation of the environment (soil pollution, toxic gaseous liberation, etc.).

Materials	Potential impact type: × = identified impact - = no identified impact 0 = no available data				Chemical toxicity	Particular pollution associated with specific plant	Possible actions	Dangerous waste
	Ground water pollution	Air and atmospheric pollution	Soil pollution	Flora and fauna pollution				
Steel	×	-	-	×	No	No	recycling	17 04 05
Aluminum and aluminum alloys	×	×	0	×	Potential	Yes	recycling	17 04 02
Asbestos	×	×	×	×	Real	Yes	No	17 06 01
Wood	-	x	-	-	No	Yes	Incineration or re-use	17 02 01 / 17 02 04
Rubber								19 12 04
Cement + asbestos	See asbestos							
Cement	-	-	-	-	No	Not identified	Not identified	0
Compounds (polyethylene)								0
Plaster	Inert waste							
Lead	×	x	×	×	Real	Yes	recycling	17 04 03
Resin	-	-	-	-	No	No	recycling	19 09 05

Table 1. Generic qualitative environmental impacts analysis that can be generated during decommissioning operations – Principal materials

Disassembling feasibility and decommissioning processes analyses

Up to now, the existing processes combined with the limited recycling processes available in the nuclear field (except the lead recycling process of AREVA NC Marcoule) and the induced drastic cost, do not allow TN international to favour recycling.

This implies that the actual TN International policy regarding decommissioning of cask is targeted on a direct disposal of cask in dedicated ANDRA nuclear storage centre with a systematic radiological characterization and a permanent goal of limiting the amount of non-conditioning nuclear waste. Two types of storage facilities have been operating in France since 1990, each corresponding to a targeted level of activities, table 2. The VLLW (Very Light Level of Waste) storage facility is located near the town of Morvilliers in eastern France, and the LLW-MLW (Light Level of Waste or Medium Level of Waste) storage facility is located near the town of Soulaines in eastern France.

Waste	Activity per unit of mass (Bq/g)
VLLW	$A < 100 \text{ Bq/g}$
LLW	$100 \text{ Bq/g} < A < 10^5 \text{ Bq/g}$
MLW	$10^5 \text{ Bq/g} < A < 10^8 \text{ Bq/g}$
HLW	$10^8 \text{ Bq/g} < A < 10^{10} \text{ Bq/g}$

Table 2. ANDRA radiological requirements

THE DECOMMISSIONING PROCESSES: WHY AND HOW?

The previous chapter was aimed to explain the origin of the project. As the perimeter, the constraints and requirements are set; the next stage was to design the process following a step-by-step approach. In order to make this new business viable, financial evaluation was performed in order to establish the annual budget for decommissioning activities and hence forecast a 10 years program.

Business process mapping was applied in order to perform the design. The decommissioning processes design by TN International follow the steps describe below in figure 1:

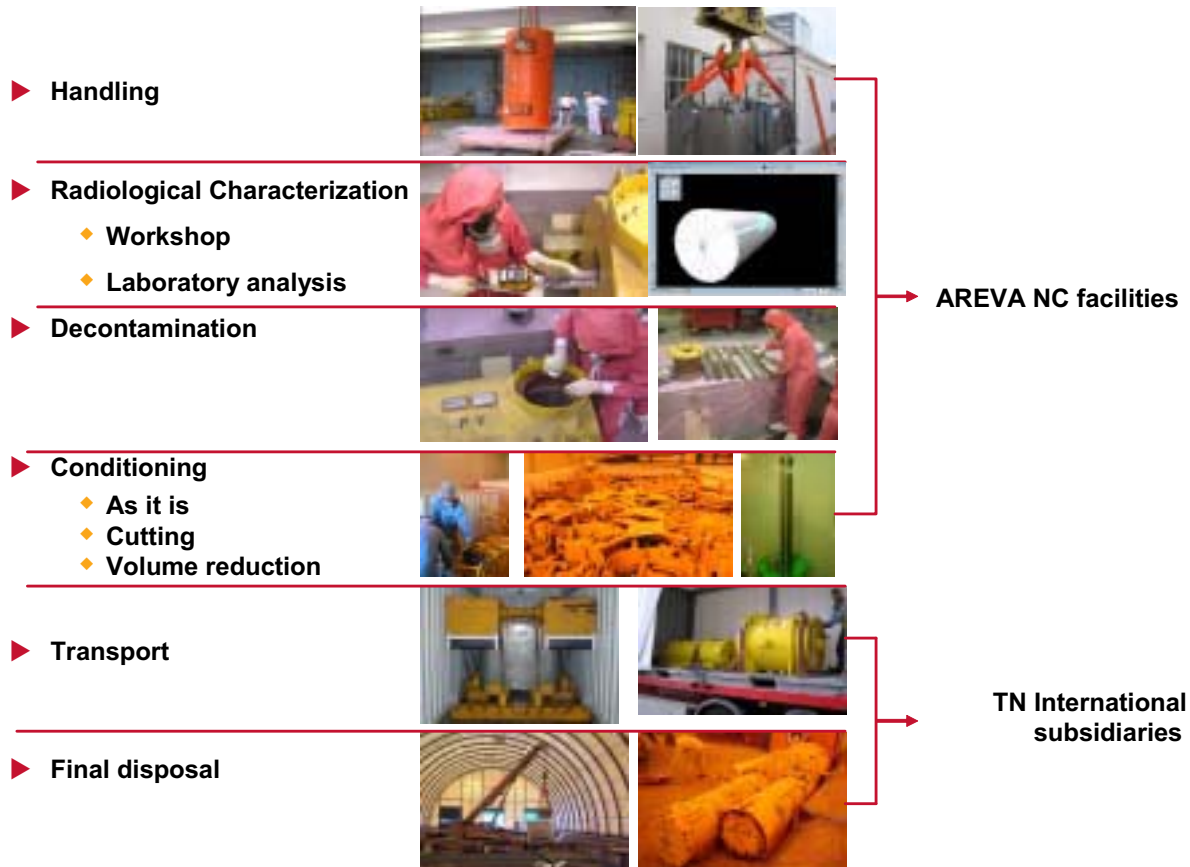


Fig.1. Decommissioning process

Cask handling operations are required when casks returning from industrial use, must be conditioned in specific containers to prevent external damage, such as weather, operational accidents during temporary storage on site, etc. Each year, when the annual dismantling program is set, casks plan for final disposal at ANDRA are removed from the ISO containers.

ANDRA final storage approval procedure:

TN International must comply with ANDRA requirements to be able to store its obsolete casks at the nuclear storage center. This ANDRA approval is provided after examination of a decommissioning file that must contain the following items:

- Description of the waste (quantity of casks by type, size, mass...)
- Description of the physical and chemical nature of the waste. General ANDRA specifications classify forbidden waste by its type: for example, explosives, liquids, reactive products, etc, are all forbidden. In this category, specific requirements exist only for wood
- Description of the radiological techniques and measurements,
- Description of the conditioning and transport procedures,
- Origin of the contamination during exploitation

Radiological characterization:

The casks' radiological characterization is performed to orientate the Very Low Activity or the Low Activity outlet, as far as ANDRA Nuclear Storage Centers are concerned as well as to calculate the radiological indicator, the IRAS value.

This calculated value is based on the knowledge of the cask isotope spectrum and the radiological activity of each isotope, using the following formula:

$$\text{IRAS} = \sum_i \frac{Am_i}{10^{\text{classe}_i}}$$

Where:

- A_{m_i} is the activity per unit of mass of radionuclide i (in Bq/g) in the waste mass,
- Class i is the number of the TFA class (values are 0, 1, 2, or 3) to which the radioisotope i belongs.

A set of wastes will be acceptable to the very low level storage facility if it simultaneously respects, at the date of delivery and declaration of activity, the following conditions:

- $\text{IRAS} \leq 1$
- The packages that make up the entire set must comply with: $\text{IRAS} \leq 10$

The driving principle of radiological characterization follows an iteration logic which is based, initially, on a documentary investigation prior to decommissioning operations. The main goal is to minimize operations taking place in laboratory or dedicated cell in nuclear workshop.

This principle is the following:

- Documentary investigation: The basic principle of documentary investigation consists in analyzing the historical operating file of each cask, which contains maintenance and transport data.
- Modeling of the dose rate transfer function:
First of all, considering the geometrical characteristics of the cask, its internal cavity is modeled by a specific dose rate transfer function made a by radiological measurement expert. A radiological spectrum is then chosen. At this stage, the spectrum is for instance a spectrum of the workshop where the cask has been maintained or it can either be the spectrum of the waste treatment plant where the cask was disposed or where it has been exploited.
The activity is then considered as homogeneous in the cavity of the cask.
In the case of the Very Low Activity storage, for an IRAS value of 1 (this is the limit value for acceptance of the cask for final disposal), we have the maximum theoretical dose rate values at several chosen spots that are determined by the dose rate transfer function. The measured dose rate value must not exceed these theoretical values.
- If the measured values are higher than the theoretical ones, it is possible to change the modeling of the cask by positioning the "hot spots". The transfer function may as well need reworking. The hypothesis is now with a heterogeneous contamination and not a homogeneous one.
- For the Very Low Activity, if the IRAS calculation is still superior to 1, an "isotope spectrum analysis" may be necessary. This technique is performed using a smear test

made on the internal cavity of the cask. It is aimed to determine the isotope spectrum in terms of radionuclide and proportion. This Laboratory isotope spectrum analysis is required when the “plant spectrum” is considered to be penalizing.

- Following the results, a spectrometry γ in situ, in addition to the “isotope spectrum analysis”, may be necessary to obtain a more accurate IRAS value.
- If the results are not acceptable (IRAS value still up to 1), decontamination will be necessary or a Low Activity final storage approval procedure will be required.

Conditioning:

Cask conditioning is required by ANDRA when the density of the waste is far below the value of 1.

Up to the value of 1, the casks may be delivered as they are without specific conditioning.

Below the value of 1 the cask can be disposed open without conditioning if the surface contamination on the internal cavity is lower than 4 Bq/cm² in $\beta\gamma$ radionuclides and 0,4 Bq/cm² in α radionuclides and the dose rate does not exceed 2mSV/h. The void volume of the cavity is then filled with sand at ANDRA.

In the case that the cavity of the cask is too contaminated to deliver it open and it is not possible to store it closed because of the size of the internal cavity, the cask is filled with crashed internal casks equipments which are usually conditioned in 1.2 m³ strengthen big-bags.

Both pictures below show internal cask equipment before and after crashing, photos 1 & 2. With this method the cask volume is reduced up to 90%.



Photo 1. AA204



Photo 2. Compressed AA204

Volume reduction (about 50%) is also possible cutting off casks. It has been realized on specific casks, figure 2 and photo 3.



Fig.2. FS05 Cask



Photo 3. Cut off FS05 in ISO 20' container

Transport:

Cask conditioning operations are required to perform the transportation operation. These can either use a cask transport frame or a specific container where the cask will be disposed within a dedicated storage system.

Transport is performed using dedicated trucks for nuclear transports. Each transport complies with IAEA regulations as well as with road regulations.

Depending on the weight, casks which are disposed as they are, are transported either in a standard ISO container (weight less than 8 tones) or on a specific container (Taut liner) where they're wedged with specific girders. This container is dedicated to this type of transports. The casks that are stored open may be transported in separated parts or may be delivered closed and then be open in the ANDRA cave. For each transport, a specific stowage is performed.

The wastes are disposed by layers at the final storage at ANDRA. Since each layer is dedicated to some specific types of wastes (volume, weight, type...), a disposal program is required. For example, wastes heavier than 12 tons, which are delivered at ANDRA on a specific container, can only be stored at the zero level of the cave. The period when the zero level is exploited lasts only two months each year which limits the potential deliveries.

The casks sent are they are at ANDRA are directly unloaded in the cave. The truck gets down in the cave. However if they're delivered in an ISO container, the containers are stored in a temporary storage facility.

TWO YEARS OF OPERATIONAL FEEDBACK: A PERMANENT AND COST-EFFECTIVE ACTIVITY

This Chapter will present two years of operational feed back. As stressed in the previous chapter, TN International main goals was to start a new activity in a field practically unknown for the company by taken into account all the constraints and requirement from all possible sources in addition with a cost-effectiveness target.

The first casks deliveries start in December 2005 with the disposal of IU05 casks that represented at the time the first cask ever to be stored at ANDRA and the most weighted as well. Since this date, 1450 casks have been sent to ANDRA (450t): 100 have been disposed as they are (280t), 950 cut-off casks in ISO containers (165t) and 400 crushed internal cask equipments (5t). During this period, the financial goals were reached compared with TN International built funds.

As a synthesis:

- Casks stored as they are in the cavity at ANDRA delivered on a trailer: 25 casks
- Casks stored as they are in the cavity at ANDRA delivered in ISO container: 75 casks
- Internal casks equipments: 300 have been conditioned in big bags and 100 have been delivered in an empty cask delivered as it is at ANDRA.
- Heaviest casks delivered at ANDRA: 3 IU05 – 24,2t each (the limit load of the crane is 25t)
- Up to now, 33 different types of casks have been disposed and imply the delivery by ANDRA of 23 agreements

A CONTINUOUS ACTIVITY IN PERPETUAL MUTATION: TOMORROW DECOMMISSIONING PROCESSES

Today, as the decommissioning processes enter its maturity phase, the annual delivery is up to 100 tons per year. Nevertheless, as technical problems are progressively sorted out, TN International has to face new challenges due to the fact that each concept is unique and after more than 40 years of exploitation and change in ownership, most of data from transportation and maintenance have vanished. In addition, the conditions of acceptance at ANDRA tend to become more and more drastic and selective, therefore TN international must deal with this new problematic in order to evolve the decommissioning processes. This chapter will introduce the new decommissioning processes that are currently under investigation.

Conventional issue

Some European countries, such as England and Germany, have set a liberation threshold value that allows nuclear industrials to either treat, recycle or eliminate nuclear wastes in non-nuclear circuits. These European countries have applied the European directive and have set liberation thresholds either in terms of activity per unit of mass or universally (depending on the material, its origin and its destination).

The French safety authority has decided to not lay down a liberation threshold value in its national regulations. Nevertheless, the French authority retains the possibility of authorizing the liberation of radioactive materials to controlled recycling or elimination facilities in individual cases. The procedure takes several years and authorization is not guaranteed.

TN International has studied the feasibility of such treatment process for its raw nuclear materials and for transport casks, such as the FS04, FS05, FS51, and FS52.

Taken into account the sustainable development principles that stress the preservation of natural resources and hence the preservation of the filled capability of nuclear storage centre, the nuclear field in France is now waiting for a clear definition of liberation threshold that will permit industrials to adopt an optimized nuclear waste management and start decommissioning and dismantling at an industrial scale.

Use of new containers

The LR31-LR32-35 are used to store the uranyl nitrate. Today a thousand of them have to be dismantled. Because of the void volume of the cavity this flask must be cut off. However the level contamination inside the tank is undoubtedly higher than the surface contamination requirements for disposal at ANDRA. TN International is studying the three identified solutions:

1. The use of new containers: The tanks would be cut off and conditioned in 7m³ containers filled in with concrete at ANDRA
2. The decontamination: The tanks would be cut into two parts to be decontaminated to reach the ANDRA requirements

3. The filling: The tanks would be cut also and filled in with crashed other flasks or with contaminated soil.

A study must be performed to compare the cost of each solution to its technical feasibility.

Material recycling

The today operational material recycling processes in France concern only lead and steels (woods can be incinerated for volume reduction but final wastes have to be sent to the ANDRA storage):

- The lead recycling process of AREVA NC Marcoule consists in a preliminary operation of decontamination of ingots into a furnace which is located at the ADM. The resulting non contaminated ingots are used to perform radiological protections to be used in the Marcoule plant.
- The Centraco plant performs radiological shielding made of steels with possible pieces made of copper and aluminium in very low proportions. The melt metal is moulded either in cylindrical ingots or in cylindrical shells. The dimensions of these shells are compatible with the internal cavity of concrete waste storage canister, and have the function of radiological shielding for wastes which will be sent to the ANDRA storage facility.

Today, the copper and aluminium recycling processes are in the study phase, but would not be applicable to the flasks. Copper process will be well adapted to electrical cables but not to flask cooling fins. Aluminium process will not be compatible with the casks baskets or cover plugs because of the residual contamination.

LR05 type cask presents more than 70% of its weight with lead. So TN International intends to use the existing recycling lead process developed by AREVA NC Marcoule. A joint project has started with CEA FAR and TN International in order to gather the competency of CEA in washing and decontamination and of TN International in decommissioning.

Low Level and Medium Level

For radiological values of waste exceeding IRAS of 1, the LLW-MLW storage centre has to be favoured for obsolete used fuel transportation cask. TN International has the ambition to start this project in the year to come, then and again, feasibility study has proven that a complete dismantling of a 100t cask is out of the standard specifications and will be a massive cost for the company, so negotiation will start with ANDRA in order to find an acceptable issue for the producer of the waste and the storage centre.

The possible outlets are:

- Direct storage without conditioning
- Storage inside an injected container

CONCLUSION

Today, with the revival of the nuclear field starting with the manufacturing of the EPR in Finland and in France, and the questioning of the public opinion regarding the "life time" of power plants, the future dismantling of nuclear power plants and facilities and decommissioning will become a subject of major concern in the world.

TN International has anticipated this new age by prioritizing decommissioning of its obsolete assets. The next stage will be to make benefit of these operational feedback to all entities of the AREVA group and external customers. The current perimeter should also be enlarged to all associated equipments which are similar to a cask with which techniques and methodologies designed could be applied.