
AREVA

Overview of Used Fuel Transport Casks

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LOGISTICS

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INTRODUCTION

- The role of BU Logistics in AREVA
- TNI and Used Fuel transport
- Transport Fleet (Trucks, Casks)
- Used Fuel cask
- HLW cask
- Fresh MOX Fuel Cask
- Conclusion

Logistics BU Profile

- **The Logistics BU is present at all stages of the nuclear fuel cycle. With its expertise, it oversees all AREVA transport throughout the world.**

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Our Position within AREVA

Mining	Conversion, Enrichment & Fuel	Reactors & Services	Back End	Renewables
				
			Recycling **Logistics** Nuclear site dismantling Clean up	

Logistics BU

A global offer which includes:

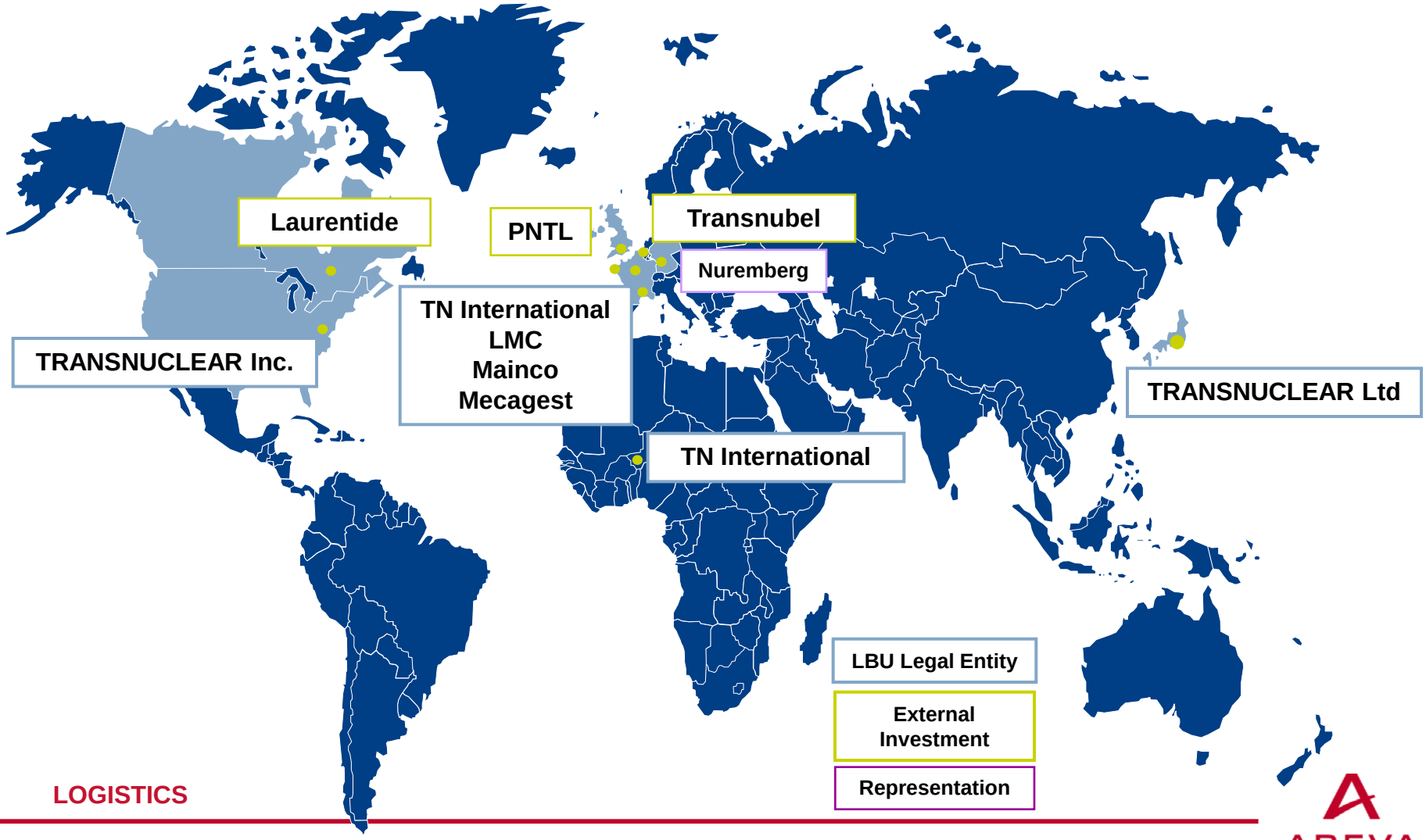
- **Design and manufacturing of casks for the transportation and storage of radioactive materials**
- **Provide logistics services and shipments under the best safety and security conditions**

Logistics BU Missions

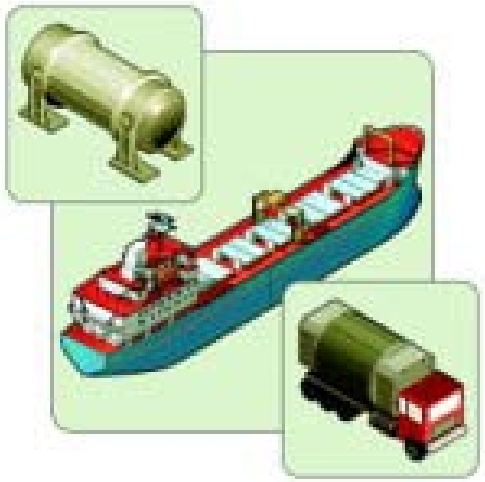
- **Secure material and associated information, from transportation preparation to delivery, through strong risk management**
- **Ensure transport operations for AREVA customers and suppliers as well as for other nuclear operators**
- **Supply dry storage solutions for electric Utilities worldwide**

45 years of know-how
to our customers' advantage

Globalization of the Logistics BU Network



Strengths and Opportunities

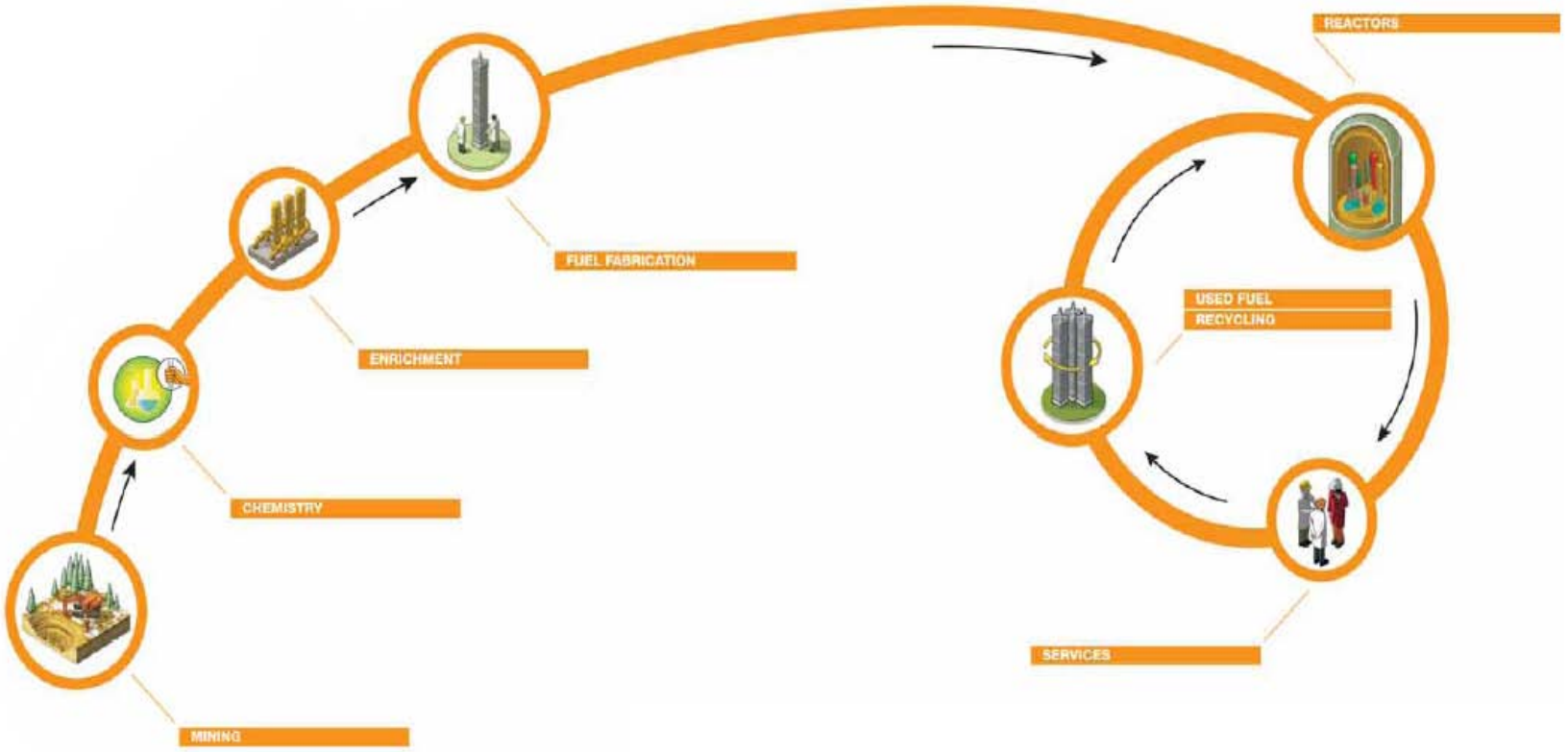


- **Our strengths**
  - Exceptional experience and international recognition
  - Excellent management of major logistics projects
  - The highest level of safety and security in the world
- **Our main opportunities**
  - The global revival of nuclear power
  - Maintenance of existing nuclear plants

New Offers to Respond to our Customers' Needs

- Fleet management & transport organization: CEA, Fuel BU, Mining BU
- New innovative casks for:
  - Dry storage systems
  - KKG vitrified residues
  - EDF Used fuel
  - Japanese compacted waste
- Supply chain management for AREVA TA
- Pool racks for Taishan and neutron shielding resin for EPR™

Our Ambition



Affirm our position
as AREVA's Reference in Logistics

TN International : Used Fuel Transport

- **TN International manages the transport of our customer who delivered the fuel to La Hague.**
  - **For this activity of transport we have developed a large fleet of casks.**
  - **Typical casks are TN®12/2 and TN®17/2 for the last 30 years**
  - **New generation of cask has started to be used in 2008 and are named TN®112, TN®117, new casks such as TN®12G3 are under design.**
- **After reprocessing we also performed the return to the customer.**
  - **Pu under the form of MOX fuel: MX6, MX8, TN®12/2**
  - **HLW-High Level Waste residue: TN®28, TN®81 and TN®85**
  - **Compacted Waste)- TN®843**

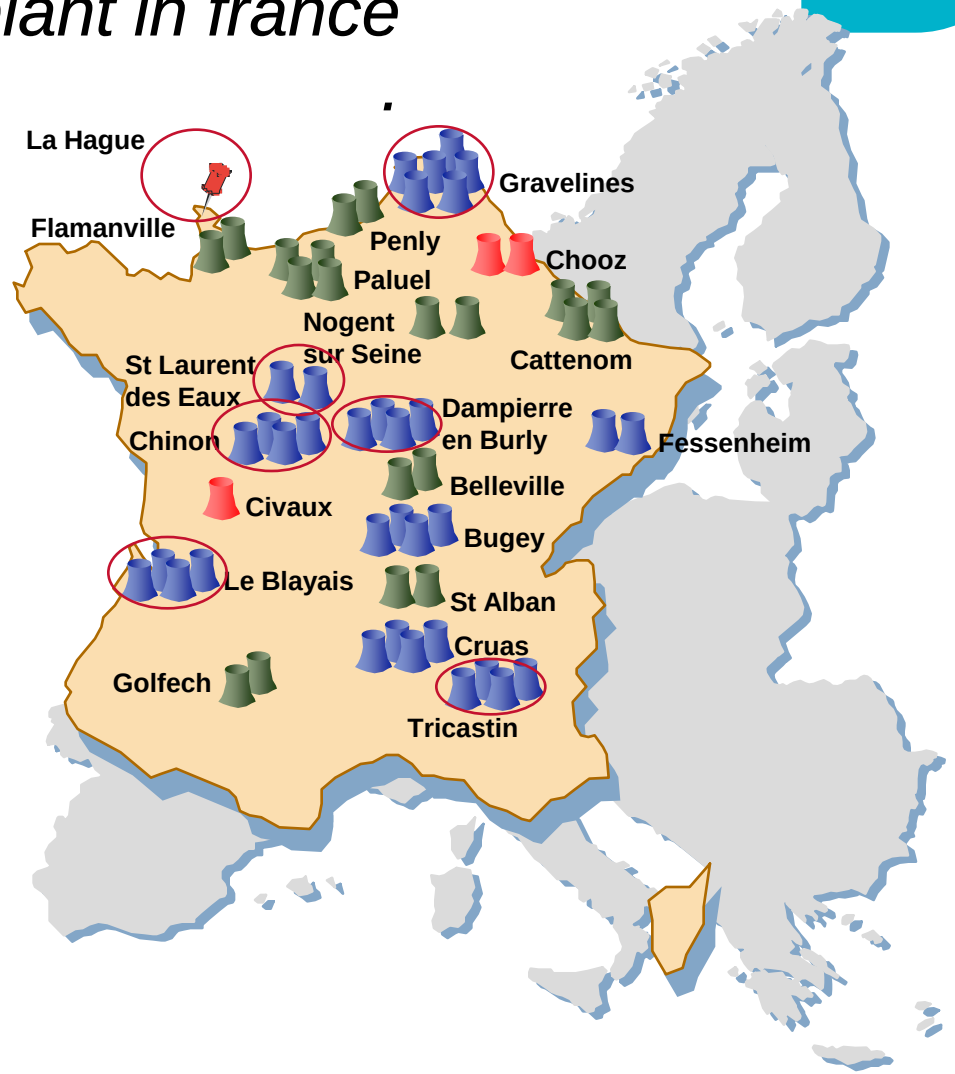
Transport Figures

- **Over the last 30 years we transported to La Hague around**
  - **3000 tons of Used Fuel From Japan**
  - **8000 tons from the European Customers (Germany, Switzerland, Belgium**

- **Typical figures of transport for 2010 are:**
  - **202 Used Fuel casks**
  - **21 High Level Waste/Compacted Waste casks**
  - **66 MOX fresh fuel cask**
  - **86 PuO2 transport**

Each year TNI Transport in Europe the equivalent of half of the Used fuel unloaded from the reactor in the US

FOCUS on French transport from Location of the Nuclear plant in france



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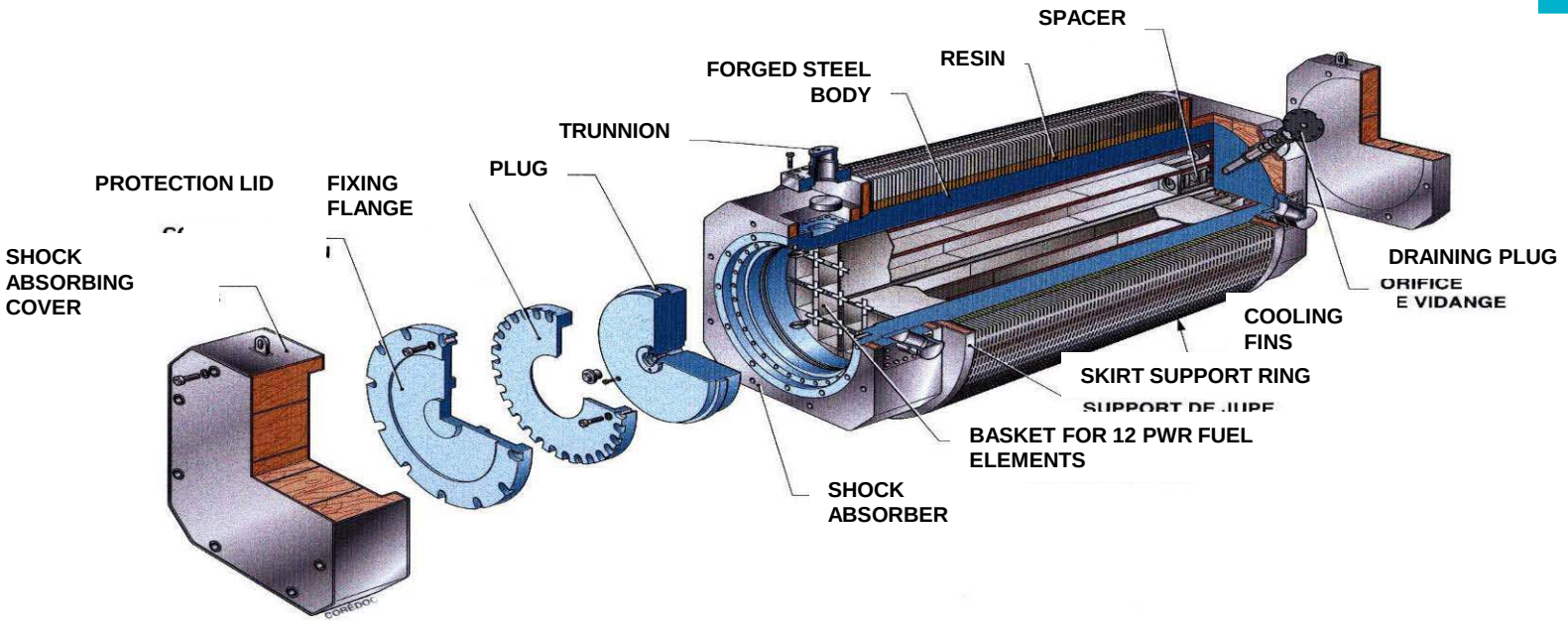
Transport fleet

- **Means of transport**
- **Typical Casks for UO2, UO2andMOX**
  - **TN®12/2 designed for UO2 Used fuel and adapted to MOX transport**
  - **TN®112 designed for MOX Used fuel and adapted to UO2 Used fuel**

Transport means

Dedicated truck and rail wagon to transprot heavy casks (from 70ton to 125ton)

TN®12/2



- **12 PWR 15x15 or 17x17 (reactor 900 MW) Or 8 UOX + 4 MOX Or 32 BWR basket 8x8, 9x9**
- **Maximal thermal power: 63.25 kW**
- Maximal enrichment in U5: 4.55%
- Maximal burn-up: 60,000 MWd/tU
- Min cooling time: 180 days

	Loaded	Empty
Weight (t)	**110**	**101.2**
	Length	Diameter
Cavity (mm)	**4,590**	**1,220**
Overall (mm)	**6,150**	**2,500**

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In addition it transports as well the MOX fresh fuel From Europe to Japan

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TN®12/2:DRY UNLOADING CELL

TNI's CASKS FOR MOX
Irradiated transport

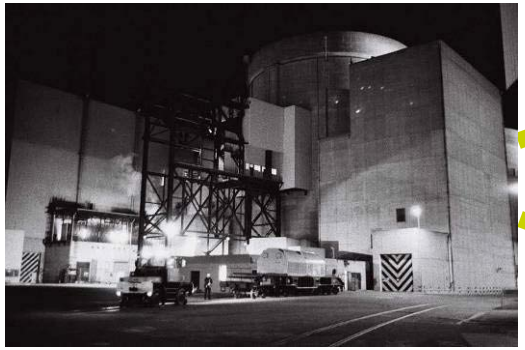
- **When MOX fuel were introduced into the EDF Plant in 1987, TNI has considered first the TN®12/2 for the transport formerly designed for the transport of UO2 Used Fuel.**
- **MOX Used fuel can only be loaded in the 4 compartments in the center of the basket, thanks to the « shielding » provided by the 8 peripheric assemblies. This ratio is compatible with the UOX / MOX ratio in core.**
- **MOX assembly is equivalent to a 3.25% UOX assembly, and are loaded into the core with 3.7% UOX assemblies.**

To the need of a new cask TN®112

- Over the year EDF chose to improve the MOX core management by moving to Parity MOX program. MOX fuel assemblies performance are increased to be equivalent to a 3,7% UOX assembly.
- Subsequently of MOX Parity the BURNUP of MOX fuel increased leading to a significant increase of the neutron radiation. Considering EDF limitation of the assembly cooling time in pool, this increase is to important for the neutron shielding thickness of TN®12 casks.
- Consequently, a new design was required to evacuate MOX Used fuel assemblies : TN®112

TN®112: a New Transport Cask

- **A new transport cask designed to transport:**
  - **PWR used fuel 17x17 from 900 MWe power plants**
  - **Capacity**
    - Up to 12 MOX used fuel assemblies
    - or MOX mixed with UOX used fuel assemblies



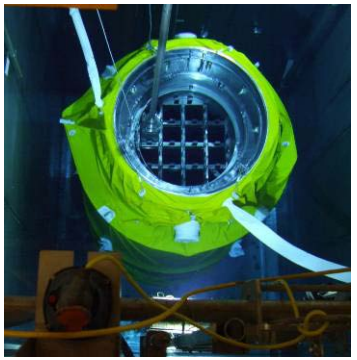
900 MW reactor

Used fuel

AREVA La Hague reprocessing plant

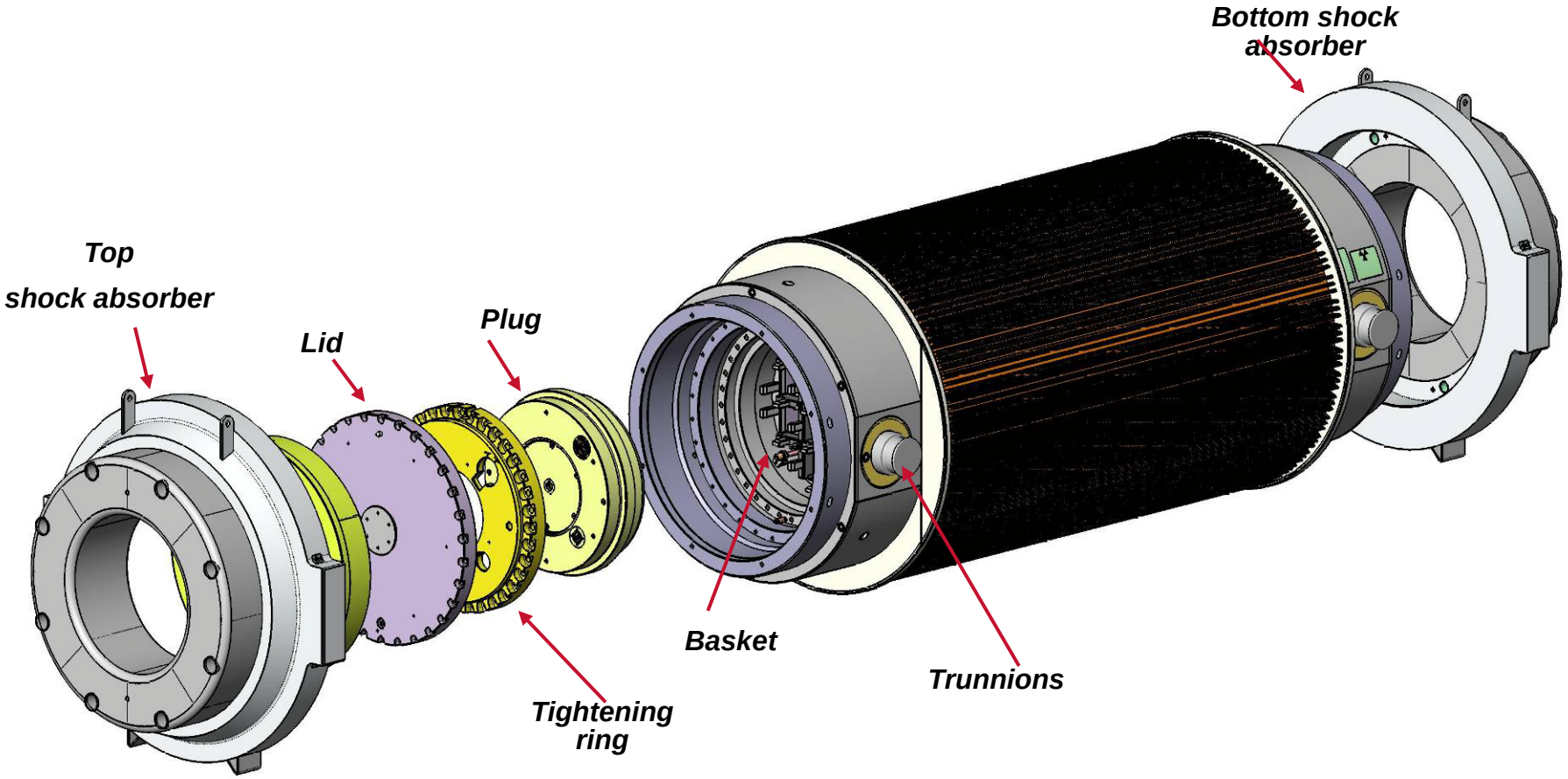
High Performance Cask

- **Performance:**
  - **Maximum thermal power: 50 kW**
    - 4.16 kW /assembly
  - **MOX enrichment: 9.3 %**
  - **Maximum average burn-up: 50,000 MWd/tU**
  - **Cooling time 392 days for UOX and 839 days for MOX**
  - B(U) type certificate in accordance with AIEA regulations (2005 edition) (F/396/B(U)F-96 (Aa))



- **Main features**
  - **Loaded weight: 114.5 t**
  - **Cavity diameter: 1,220 mm**
  - **Cavity length: 4,136 mm**
  - **External diameter: 2,790 mm**
  - **External length: 7,001 mm**

TN®112 Cask Diagram



Main difference between TN®12 et TN®112

- TN®112 is licensed by the French Competent Authority under IAEA-96 (transport regulation)
- TN®112 is a double containment barrier
- TN®112 is made with compound of steel, lead WHILE TN®12/2 is made of one thick forged steel. Both casks are surrouded by resin compound.
- Trunnion on the TN®112 are out of the active length of the fuel
- Radiation around the cask, Criticality and containement analysis are evaluated according to the overall typical data of a fuel after irradiation.
- Basket inside the cavity are designed to meet the safety criteria with propriate material including or not Boron in the alloy matrix of the wall between the lodgement of the basket
- In term of operation the new design of TN®112 improves the dose rate around the cask.

Main Operation around the cask

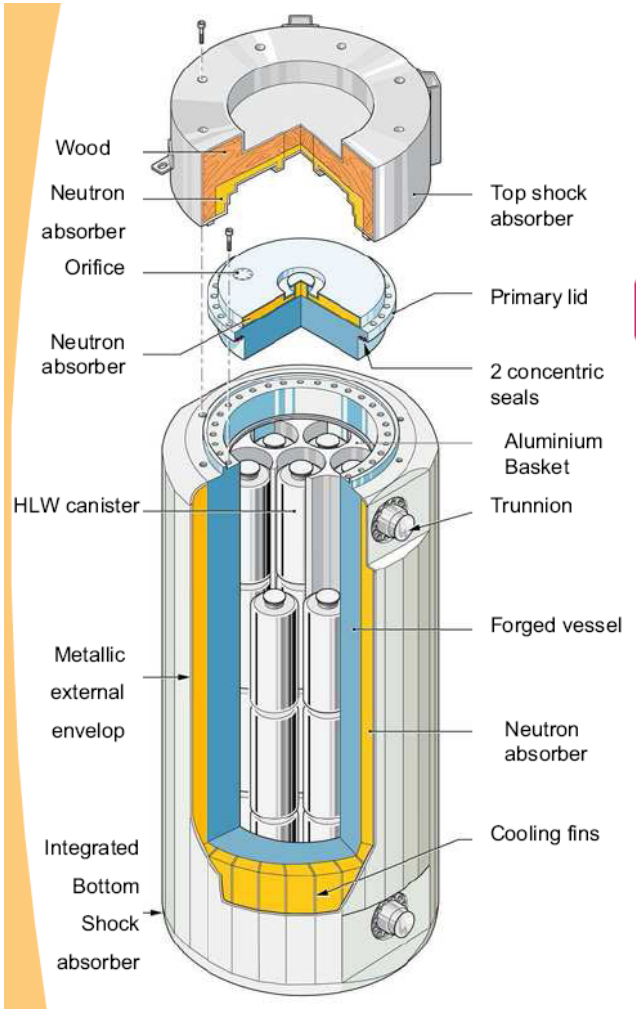
	TN®12/2	TN®112
LOADING CONDITION	WET	WET
UNLOADING CONDITIONS AT LA HAGUE	WET or DRY	WET so far
Draining	Orifices at the bottom of the cask	Diver hose

Difference between Fresh fuel and irradiated

	MOX Fresh fuel	MOX irradiated Fuel	UO2 fresh fuel	UO2irradiated fuel
Type of package	Type B - Fissile	Type B - Fissile	Type A - Fissile	Type B - Fissile
Security AIEA – NSS13(INFCIRC225 rev5)	Cat I	Cat II – Irradiated	Cat III	Cat II - Irradiated
Fuel Integrity required by fuel vendor	Concerned by Vibrations and shocks during the transport		Concerned by Vibrations and shocks during the transport	

TN®28 for HLW- Overview

TN®28 Cask for HLW



TN®28 for HLW

- 13 overseas transport achieved to Japan since 1995
- The cask is loaded with 20 or 28 canister (see picture)
- Loading/unloding : dry

Main Features

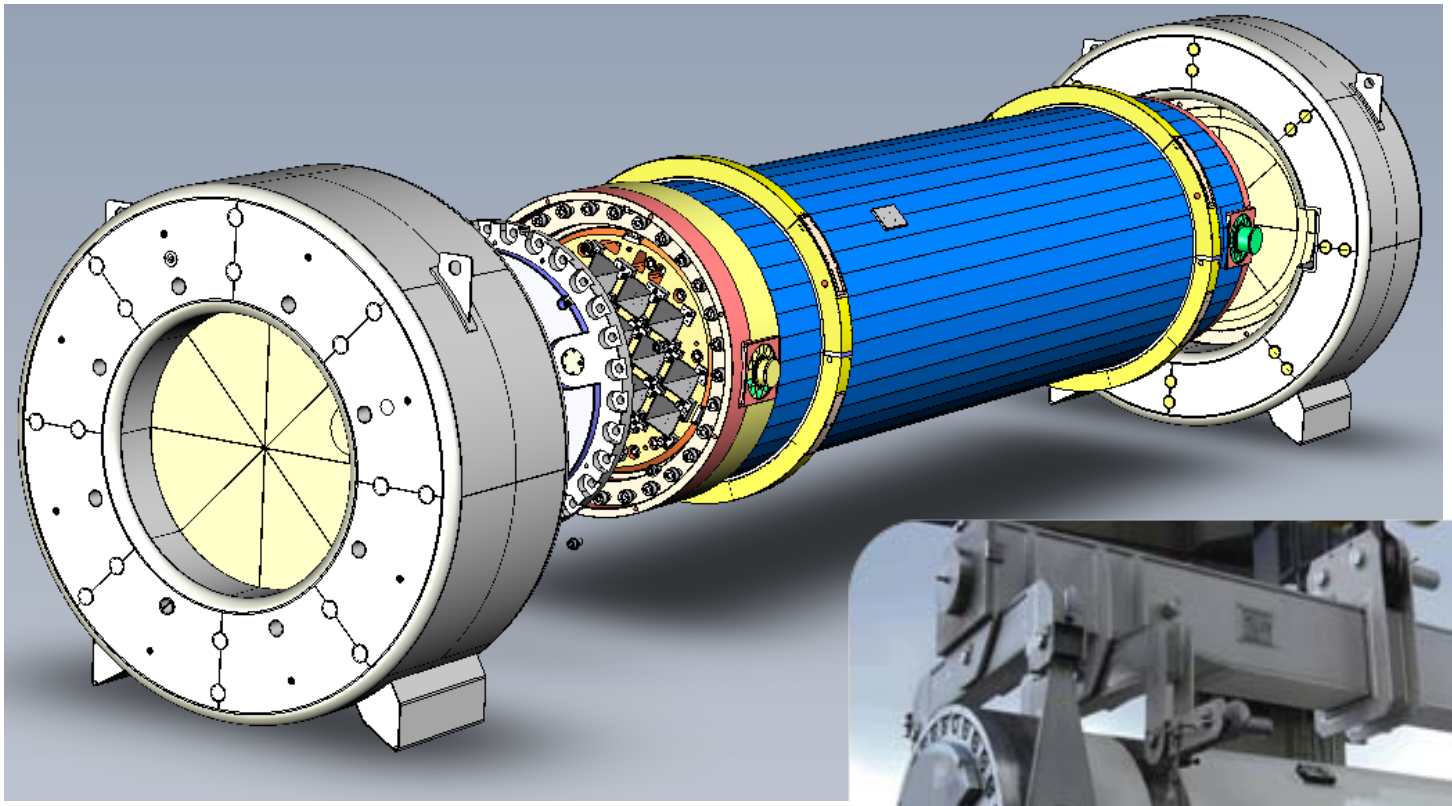
	Loaded	Empty
Mass	112 t	94.8 t
	Length	**Diameter**
Cavity	5,189 mm	1,385 mm
Overall	6,607 mm	2,480 mm

Figure 9 : Vue extérieure des colis CSD-V et CSD-C

MOX Fresh Fuel towards Japan in TN®12/2

- Delivery of MOX Fresh fuel in Japan:
- TN®12/2 cask licenced for transport of 8 PWR or 21 BWR.

MX6 Casks for MOX fresh fuel



- **MX6 is a light cask (19.4t) for the transport of MOX between Melox and Nuclear Power Plant**
- **The content is MOX Fresh Fuel : Maximum 6 PWR or maximum 16 BWR**

Conclusion

- **Principle in the transport of Used fuel**
  - **Transport of MOX Used Fuel is achieved on a daily basis in Europe and more specifically in France.**
  - **The transport means do not differ while we transport UO2 Used fuel or MOX Used as well as HLW.**
  - **Differences appear to cope the customer needs and requirements to consider the condition of utilization, storage, transport**
  - **With the fleet of casks operated in Europe there is always a possibility to adapt (when required) the internal basket to the customer requirements.**

- **Way Forward: Study the acceptability of TN International Fleet of Cask to the US needs**