

# **INTERIM DRY STORAGE SYSTEM TECHNOLOGIES AND INNOVATIONS VARNA 2002**

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*As of MAY 17<sup>th</sup>, 2002 TRANSNUCLEAIRE name has been changed to COGEMA LOGISTICS.  
Under COGEMA LOGISTICS, TRANSNUCLEAIRE and the Transport activities of COGEMA  
are joining forces to better serve their customers.  
Both COGEMA LOGISTICS and FRAMATOME ANP are subsidiaries of the AREVA group.*

The current world-wide trend is towards expanding the Spent Fuel Interim Storage capabilities at reactors. To address this trend and to comply with NPP specific needs, COGEMA LOGISTICS has developed two main modular concepts each leading to two distinct extended families of dry storage systems. The technologies involved in these two main concepts, the TN 24 Family and the NUHOMS® System, have emerged through over 20 years experience in providing dry storage solutions to NPPs in compliance with various specific requirements in Europe, the United-States and Asia.

It is to be noted that the interim dry storage solutions presented below are derived from concepts containing a strong transport component which has emerged from COGEMA LOGISTICS unique experience in transportation and design of transport casks for the nuclear industry. Such transport component contributes to a technology that complies with stringent requirements that are internationally recognised, and provides NPPs and Dry Storage Management with additional long term options.

After explaining the main concept of both the TN 24 Family and the NUHOMS® System, we shall discuss how the NPPs specific requirements and economics trends are contributing to the growing families of interim dry storage systems delivered under COGEMA LOGISTICS license.

### **Main Concept of the TN 24 Family (Figure 1) :**

- **A Dual Purpose Transport and Storage Packaging.** Packagings derived from the TN 24 Concept are designed to be stored vertically; when required, their closure systems can be specially protected by an aeroplane crash protective cover. The TN 24 Family is presented in Figure 2.
- The main **Gamma Shielding** is provided by a forged steel shell (approx. 25 cm thick) to which a forged steel is attached by shrinkage and welding.
- **Neutron Protection** is given by a thick layer of boronated resin enclosed between the forged steel body and the external shell. Longitudinal heat conductors made of copper plates convey the heat power of the fuel assemblies from the forged steel body to the external shell.
- A **Main Lid** also made of forged steel and bolted to the cask body provides gamma and neutron shielding and maintains the leaktight containment of the cavity using metallic or elastomer gaskets.
- **The Basket, technology providing a compact spacing of the SFA for VVER, PWR and BWR types,** is made of boronated aluminium and stainless steel guarantees the sub-criticality of the contents during normal operation (including loading under water) as well as during accidental conditions.
- **Adaptability:** For the last 20 years, the TN 24 Main Concept has been adapted to produce the specific optimised dry storage solution to over 18 customers in the United-States and Europe with more than 250 packagings ordered at this time.  
The main adaptability criteria are :
  - ◆ Precise adaptation of the Boron content in the aluminium basket to U-235 enrichment
  - ◆ Optimisation of the payload
  - ◆ Optimisation of the shielding performances by adaptation of thickness of the forged steel body and the resin
  - ◆ SFA types and dimensions
  - ◆ Interface limitations of the receiving building

### **Main Concept of the NUHOMS® System :**

The NUHOMS® system is a modular concrete shielded dry storage system, which represents the majority of storage systems in the USA with more than 300 units ordered, and counts 250 units

ordered to FRAMAMTOME ANP in Europe (Medzamore and Chernobyl) under COGEMA LOGISTICS license. See Figure 3.

- **A Dual Purpose Transport and Storage System.** The NUHOMS® System is composed of Horizontal Storage Modules (HSMs), and Dry Storage Canisters (DSCs) which can be transferred from the reactor pool to the Independent Spent Fuel Storage Installation (ISFSI) or transported, using a Transportation Cask, to a reprocessing facility such as La Hague or to a permanent off-site storage facility.
  
- **The HSM** secures the following main functions :
  - ◆ Shielding
  - ◆ Mechanical protection
  - ◆ Atmosphere cooling air circulation
  - ◆ Support the DSC
  
- **The DSC** secures the following main functions :
  - ◆ Containment
  - ◆ Criticality control through its basket
  - ◆ Heat transfer to the atmosphere
  
- The **Transportation Cask** is a multi-purpose cask used for on-site DSC transfers and for transportation of loaded DSCs from the ISFSI site to a reprocessing facility or to a permanent off-site storage facility.
  
- **Transporter/Transfer and Auxiliary Equipment:** The transfer equipment associated with the Transportation cask is used to load spent fuel assemblies into the DSC, perform DSC closure operations, transfer the loaded DSC to the ISFSI site, and insert the loaded DSC into the HSM. This equipment is also designed to be used for retrieval of the DSC from the HSM. The major transfer equipment components are :
  - ◆ transfer trailer,
  - ◆ skid,
  - ◆ positioning system,
  - ◆ hydraulic ram,
  - ◆ cask lifting yoke assembly,
  - ◆ vacuum drying system,
  - ◆ automated welding system.

- **ISFIS Management.** The NUHOMS® System offers some important advantages when it comes to the size, and economies of constructing the ISFSI. The first major advantage is footprint. NUHOMS® offers the smallest footprint of any canister based dry storage system. While other systems somehow claim this honor, NUHOMS® delivers on it. This is clearly demonstrated in Figure 4 where the NUHOMS® footprint is compared to the most compact vertical concrete overpack arrangement. The result is a 25% advantage for NUHOMS® where for every 6 vertical overpacks, NUHOMS® fits 8 HSMs.

The small footprint offers several advantages :

- ◆ Reduce costs by reducing the number of pads to be built for a particular site.
- ◆ A smaller ISFSI reduces the impact on the site and allows for a larger distance between the ISFSI and the surrounding environment, which reduces fence dose. This can become critical in the future as more fuel is stored in the ISFSI and as the source term increases due to storage of high burn-up fuel.
- ◆ **Adaptability** : Since the early 80's, the NUHOMS® System Main Concept has been adapted to produce the specific optimised dry storage solution to over 24 customers in the United-States and 2 in Europe with a total of 544 units ordered at this time.

The main adaptability criteria are :

- Precise adaptation of the Boron content in the basket to U-235 enrichment
- Optimisation of the payload
- Optimisation of the shielding performances by adaptation of thickness of the concrete wall
- SFA types and dimensions RBMK, VVER, PWR and BWR
- Interface limitations of the loading building, ISFI area.

### **Adaptations / Innovations :**

World wide economics often dictate today trends with regard to ISFSI management. Trends towards : higher burn-ups, expanding the spent fuel interim storage capabilities, transportability, and benchmarking are composing tomorrow's customers requests and are COGEMA LOGISTICS' today challenges.

- **High burn-up** : Within the AREVA group, up to 20 new packages are developed each year and over one proposal for licensing or license extension is submitted each week to competent authorities world wide for new designs and extensions. Research and development is progressing towards the storage of high burn-up fuels. For example, solutions have been found for German utilities requiring burn-ups to up to **60 000 MWd/TU** : The TN 24 E packaging
  - ◆ Burn-up : 60 000 MWd/TU
  - ◆ 21 PWR fuel assemblies

- ◆ Max. enrichment : 4.45 %
- ◆ Min. cooling period : 5 years
- ◆ Max. heat load : 39 kw
- ◆ Max. diameter 2500 mm
- ◆ Licensing for storage in Germany

Thirty-three TN 24 E packagings are currently being ordered for German electricians.

- **Transportability** : Transportability is an essential criteria of choice for many NPPs. Some utilities placing part of their spent fuel in interim storage, do not want to forego the possibility of sending that very fuel to reprocessing later in time. Most European utilities have been contracting for reprocessing of their spent fuel. **Transportable Stored Spent Fuel** serves Public Acceptance for the following two reasons :
  - ◆ Showing that the fuel will not be stored forever on a given site.
  - ◆ Showing that a stringent safety approach based on internationally recognised rules is being implemented, thus allowing the neighbouring country experts to assert readily that the interim storage facility is up to valid standards.

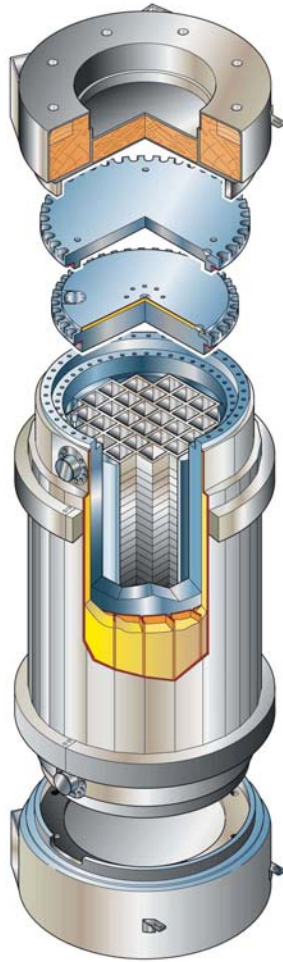
COGEMA LOGISTICS' unique experience in transportation and design of transport packagings for the nuclear industry greatly contributes to the making of **Transportable Stored Spent Fuel**, thus providing ISFSI management with long term options.

- **Expanding ISFSI Capabilities : Overall cost control of ISFSI is** impacted by the choice of a Dry Storage System capacity for a definite limited available footprint as well as by the maintenance requirements during the storage period.
- The NUHOMS® System has allowed plants such as Point Beach (USA) to significantly **increase the Capacity** of their existing ISFSI sites by switching from a vertical overpack system to the NUHOMS® technology. It is also why San Onofre (USA) found NUHOMS® to be the best fit for their relatively small and narrow site.
- **Completely passive**, the NUHOMS® System requires no major maintenance. No instrumentation or active monitoring devices are required during the storage period.
- The Chernobyl project under-construction is a perfect demonstration of the adaptability of this product to new fuel assemblies where fuel-cladding integrity was not proven. A specific conditioning has been developed: by separating the two active bundles and the extension rod and by inserting the active bundles into stainless steel cartridge under inert gas to create a second barrier.
- **Benchmarking** : Eventhough NPPs are facing similar constraints and tend to follow similar trends as indicated above, regulatory and NPPs specific requirements have generated a large variety of dry storage custom-made solutions such as the TN 24 Family and the NUHOMS®

Systems. COGEMA LOGISTICS has recognised the need for NPPs, ISFSI managers and operators to share information on their Interim Dry Storage Solutions and is consequently sponsoring regular **USER Groups** where customers and future users may benefit from on hand experience.

## **Conclusions :**

Modular solutions are currently dominating the field of spent fuel interim storage. This is because they are derived from main concepts that have evolved over time, and benefited from both the transport aspects with internationally recognised stringent regulations, and various specific ISFSI requirements and economics trends.



**Figure 1 : TN 24 Main Concept**

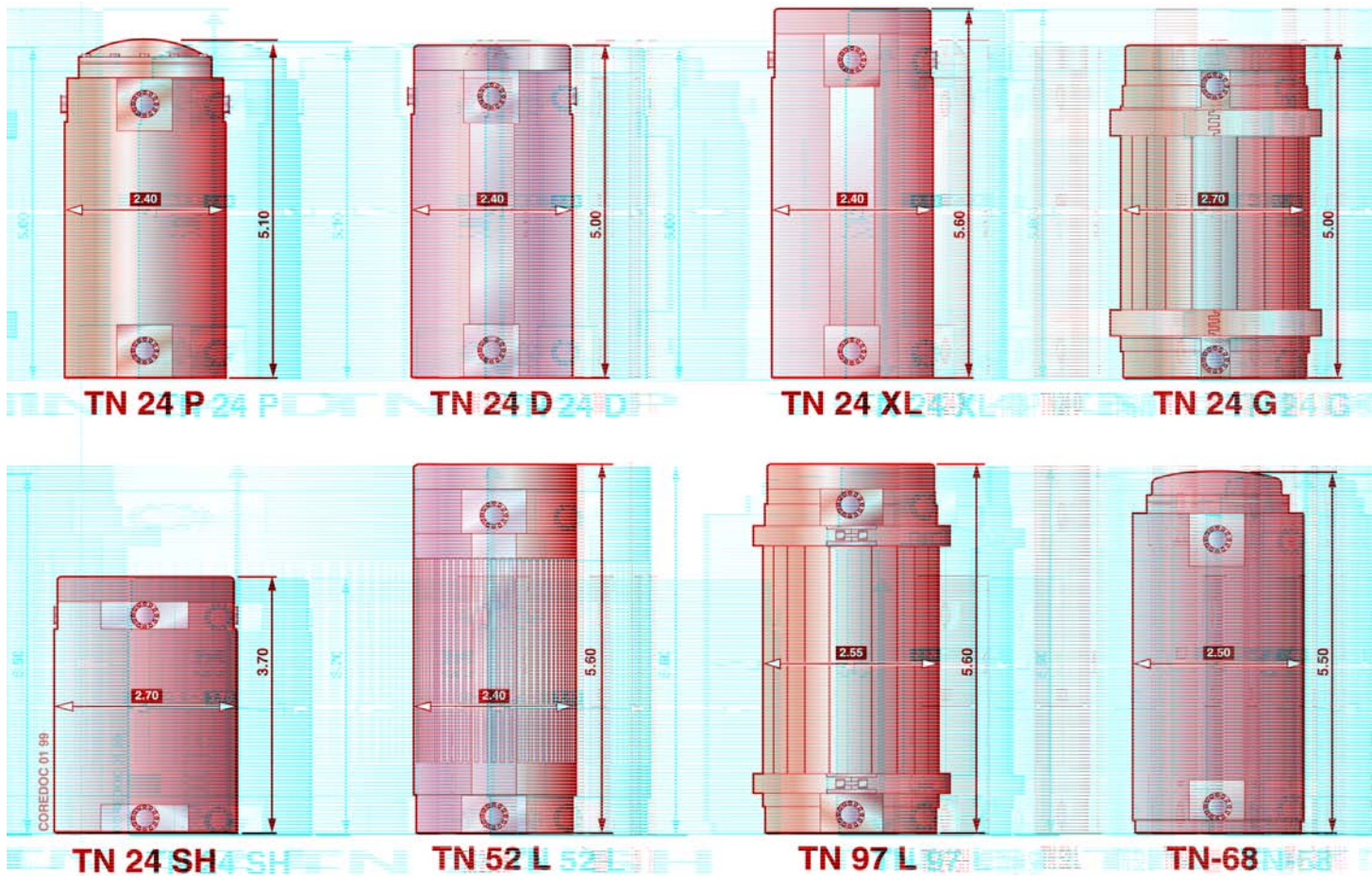


Figure 2 : The TN 24 Family



NUHOMS HORIZONTAL STORAGE MODULES

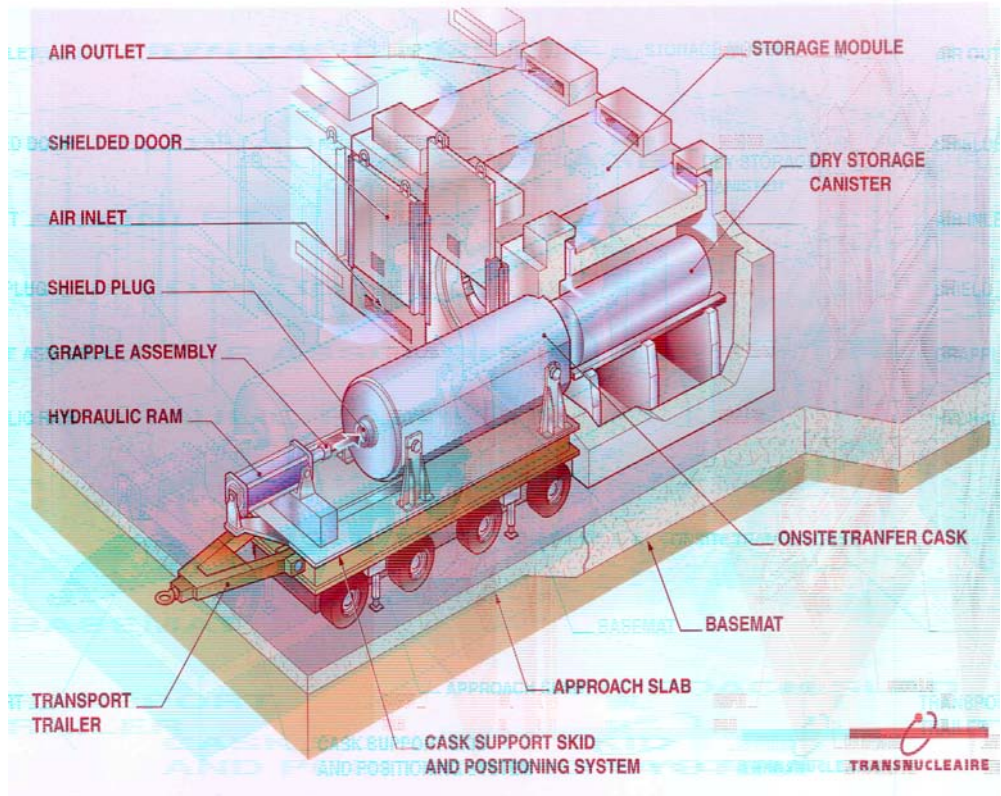


Figure 3

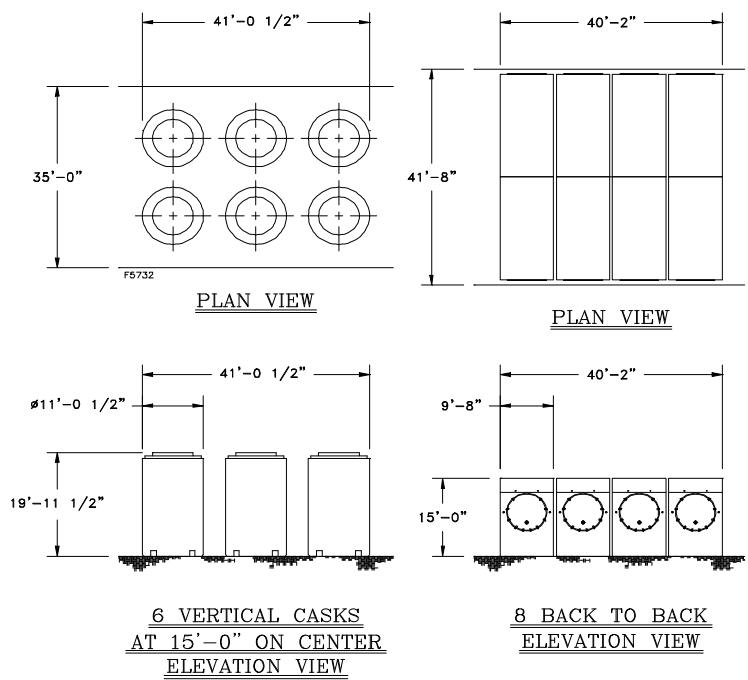


Figure 4