CHOOSING A SPENT FUEL INTERIM STORAGE SYSTEM

Key words: Spent fuel, interim storage, Nuhoms, casks, transportability

Vincent Roland, Vice President, Marketing & Sales, Transnucléaire
Ian Hunter, Vice President, Engineering, TNY

Correspondence Address:

Vincent ROLAND, Transnucléaire, 11 rue Christophe Colomb, 75008 Paris, France

Tel +33 1 40 69 76 74 Fax +33 1 40 69 85 99 E mail: vroland@transnucleaire.fr

The Transnucléaire Group has developed different modular solutions to address spent fuel interim storage needs of NPP. These solutions, that are present in Europe, USA and Asia are metal casks (dual purpose or storage only) of the TN 24 family and the NUHOMS® canister based system. It is not always simple for an operator to sort out relevant choice criteria.

After explaining the basic designs involved on the examples of the TN 120 VVER dual purpose cask and the NUHOMS 56 VVER for VVER 440 spent fuel, we shall discuss the criteria that govern the choice of a given spent fuel interim storage system from the stand point of the operator.

In conclusion, choosing and implementing an interim storage system is a complex process, whose implications can be far reaching for the long-term success of a spent fuel management policy.

The TN 120 dual purpose cask (figure 1):

The fuel assemblies considered in this design are of the VVER 440 type, with a dimension across flats of 145.7 mm and an overall length of 3,217 mm. The initial enrichment may reach 4.3 %.

The TN 120 accommodates 120 spent fuel assemblies with 55,000 MWd/tU maximum burn-up and 7-year cooling time.

In storage configuration, the overall dimensions of the cask are approximately 3.9 m in length and 2.8 m in diameter. When equipped with shock absorbing covers, under horizontal transport conditions, the cask has a length of 4.6 m.

The empty cask (without the shock absorbing covers) weighs approximately 84 tons.

Loaded with fuel assemblies (corresponding to roughly 26 tons for 120 assemblies) inserted in an aluminium basket and including two shock absorbing covers, the maximum weight of the cask is around 120 tons under transport conditions. Without the shock absorbing covers, but taking into account the weight of the handling beam and the weight of water in the cavity during loading (about 8 tons altogether), the overall weight of the cask at crane hook is approximately 118 tons.

The main gamma shielding is provided by a forged steel shell (approx. 25 cm thick) to which a forged steel bottom is attached by shrinkage and welding.

Neutron protection is given by a thick layer of borated 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 gaskets.

A basket, made of boronated aluminium and stainless steel guarantees the subcriticality of the contents during normal operation (including loading under water) as well as during accident conditions.

Aluminium has also been selected for its good heat transfer characteristics in order to convey the heat power from the fuel assemblies to the cavity wall. The basket consists of hexagonal compartments (or lodgements), each holding one VVER 440 fuel assembly.

The cask has been designed to be stored vertically. If required, its closure system can be specially protected by an airplane crash protective cover.

This "dual purpose" cask takes advantage of the already large family of existing TN 24 dual-purpose casks. It meets the requirements for the interim storage of the spent fuel arising from the operation of the Dukovany power plant. Thanks to its transportability, it can be used either on site or in a centralized storage facility.

The Nuhoms 56 V system (figure 2):

The NUHOMS® system is a modular concrete shielded dry storage system, which represents the majority of storage systems in the USA. The Nuhoms 56V is currently in use in Armenia's Medzamor site. It holds 56 VVER 440 spent fuel assemblies.

The following is a short description of each component **(figures 2 and 3)**:

Dry Storage Canisters: DSCs are licensed. The fully licensed NUHOMS®-56V canister is a stainless steel canister with a sleeves and disc basket, and 2 welded covers.

The DSC secures the following functions:

- Containment
- Criticality control through its basket
- Heat transfer to the atmosphere

Storage Casks: Horizontal Storage Modules (HSMs) are concrete storage structures, used to store loaded DSCs at the Independent Spent Fuel Storage Installation (ISFSI) until these DSCs can be transported from the ISFSI site to a permanent storage facility.

The HSM has the following functions:

- Shielding
- Mechanical protection
- Atmosphere cooling air circulation
- Support of the canisters

Transfer Cask: The OSTC, is an on-site transfer cask that transfers the loaded DSC from the auxiliary building to the HSMs located at the ISFSI site.

Transporter/Transfer and Auxiliary Equipment: The transfer equipment associated with the OSTC 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 may also be used to remove 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 (VDS) and automated welding system (AWS). Several sets of this transfer equipment are in use by our clients, and our subsidiary TNY also owns a complete set, available for lease.

Transportation Cask: The MPTC transportation cask is a multi-purpose cask that can be used for on-site DSC transfer and for transportation of loaded DSCs from the ISFSI site to a future permanent off-site storage facility.

The Criteria for choice

What are the main criteria for choice of a dry storage system from the point of view of the operators?

The basics are of course safety, strategy and economics, but these can then be subdivided in more categories:

Safety

- Is the concept licensed?
- Is it operational?
- If it is operational, what is the operational record?
- Is there a licensing risk linked to the specificities of my case?
- Do I require evolution of the concept over time?

Strategy

- Do I plan to store extremely long on the same site?
- Do I wish to be able to move/recover the fuel easily at any moment? At the end?
- Do I run into a public acceptance issue?
- If I reprocess part of my fuel, do I need interim storage capacities for the residues?
- Do I need to integrate now my end-of-life strategy for the NPP?
- What kind of basket solution do I need transportable or not?

Economics

- Do I need modularity?
- Is there a political/practical reason to localize production? To acquire technology?
- Should I favor multiple sourcing or single sourcing?
- What is my strategic discount rate?

Examples of choices and trends

USA

Dry spent fuel storage systems for use at commercial nuclear power plants are more and more required to allow for transportation of the spent nuclear fuel. This need is based on several factors:

- Compatibility with the DOE central repository requirements resulting in a desire to have a multi-purpose canister for on-site storage, transportation, and storage at the repository.
- Compatibility with the DOE central repository requirements so that the DOE will take the spent fuel canisters as-is with no need for a utility to repackage or re-handle the spent fuel.
- Public pressure wishing to make sure that the utility ISFSI's are not permanent storage facilities.

The need for compatibility with the DOE system so that the DOE will take possession of the spent fuel without fuel handling or re-packaging is based on utility concerns that the DOE will take the fuel first from those utilities that have transportable systems. The utilities do not want to place spent fuel into storage and then be required to re-package the fuel prior to DOE acceptance. This philosophy is based on the demand that any fuel handling be performed by the DOE at the repository. Also, the potential for an interim storage facility would require a system that can be transported and then stored.

The current practice in the United States is moving toward dual certified systems – systems that are licensed for storage (10CFR72) and transportation (10CFR71). This explains why more and more transportable systems like the NUHOMS® 61B and the TN 68 dual-purpose casks are being chosen.

EUROPE

Most European utilities have been contracting for reprocessing of their spent fuel. This has two major consequences:

- The power plants are equipped to handle transport casks and their operators are familiar with that type of equipment
- Even though a utility may want to place part of its spent fuel in interim storage, it does not want to forego the possibility of sending that very fuel to reprocessing later in time. Therefore it will choose not only transportable interim storage systems, but also systems that can be unloaded at the reprocessing plants too.

Other reasons reinforce this choice. Some countries have built centralized interim storage facilities and it is easier to load the fuel into dual purpose casks at the NPP rather than transport it to such facility or organizing for transfer from a transport device into a storage system at the end of the road.

European countries are, by American standards, very small in area. So opposition against to and/or concern with the storage may well come from the public of a neighboring country, as the Austrian example of pressures on the Czech and Slovak Republics has shown. Thus, transportability serves two purposes:

- Showing that the fuel will not be stored forever on the given spot, since it is transportable
- Showing that a stringent safety approach based on internationally recognized rules is being implemented. Thus the experts of the neighboring country may assert readily that the interim storage facility is up to valid standards.

Here are some instances:

Italy, with no new nuclear developments and a need for further transport towards a central interim storage to be defined chose dual-purpose casks. Because no experience had been recently acquired, they preferred to use fully licensed design approaches, such as the TN 24 GET.

In Doel NPP, Belgium needed a compact (public acceptance), transportable (reprocessing) and modular system (preserving choices). They chose the TN 24 designs **(figure 4)**.

In Tihange NPP, Belgium preferred to implement a wet storage, among other things because one of the units would be very limited in handling dry systems and would be uneconomical.

In the Czech Republic, where new choice is being made in Dukovany NPP, one of the key parameters is local content and fabrication. In addition, the capability for licensing locally is storage France and Britain favor reprocessing and thus transport directly to the reprocessing plan their spent fuel. Cask cost also favors high discount rates, thus strengthening the case for modular systems.

In Switzerland, a central interim storage, Zwilag is based on the size of the country, the combination of interim storage of gloss canisters, and consideration to further transport to a repository. It is one performa of the Swiss authorities to see the storage systems licensed for transport in the origin country.

CONCLUSION

Modular solutions are currently dominating the field of the interim storage of spent fuel. This is because they cater to many of the choice criteria.

It is nevertheless paramount that operators carefully assess their priorities and orientation before committing to one solution.

TN 120
Transport configuration

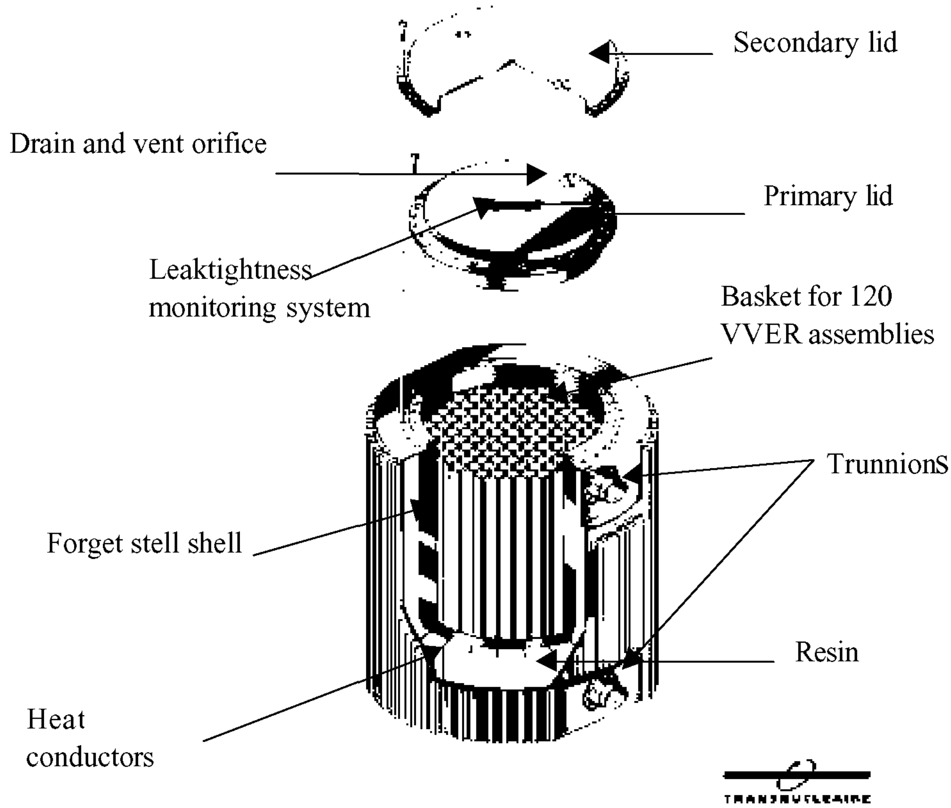
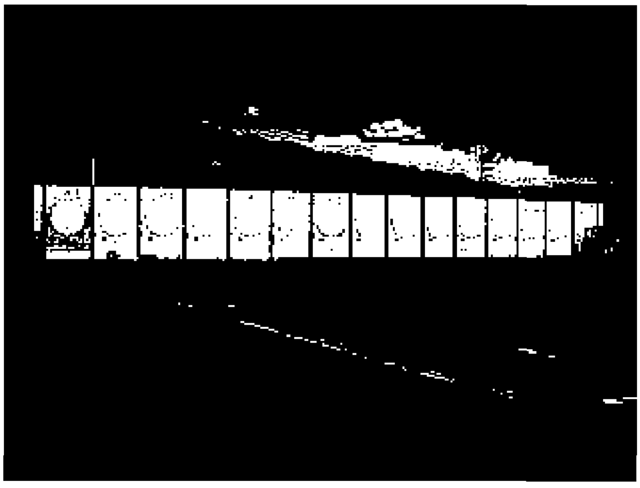
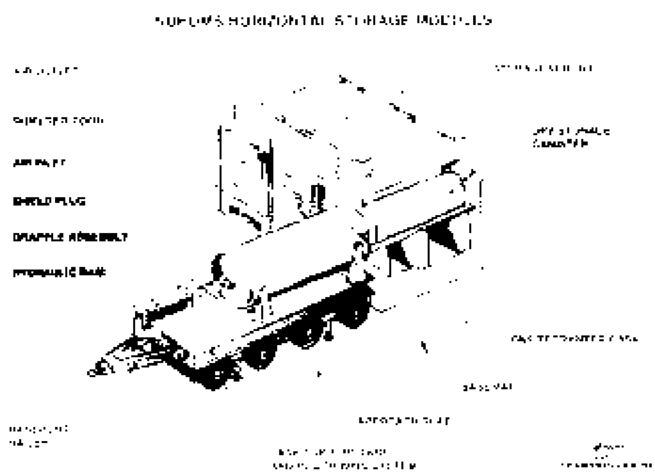


Figure 1: TN 120





Figures 2 and 3: NUHOMS DRY STORAGE SYSTEME

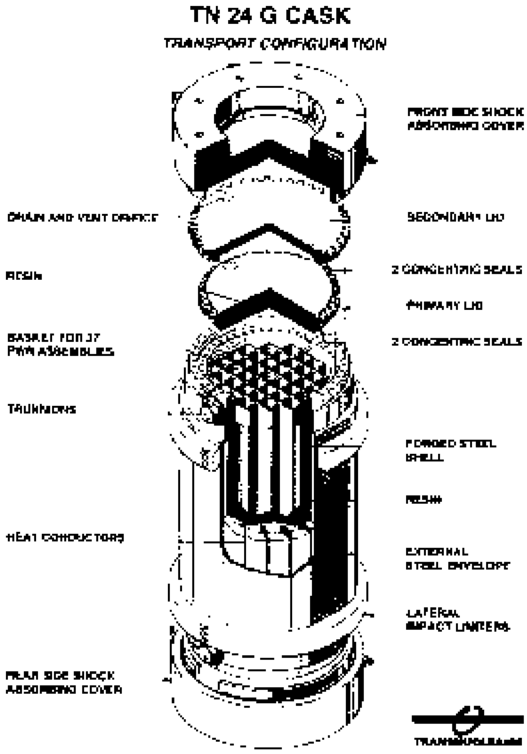
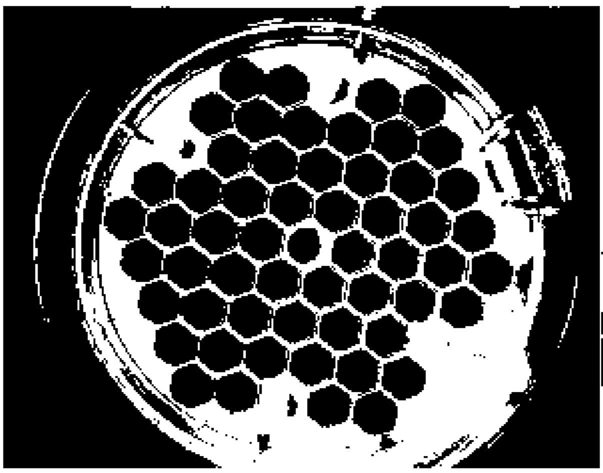


Figure 4: TN 24



Figures 5 and 6: NUHOMS 56 VVER