ABSTRACT

The current international trend towards expanding Spent Fuel Interim Dry Storage capabilities goes with an improvement of the performance of the proposed systems which have to accommodate Spent fuel Assemblies characterized by ever increasing burn-up, fissile isotopes contents, thermal releases, and total inventory.

Due to heterogeneous worldwide reactor pools and specific local constraints the proposed solutions have also to cope with a wide fuel design variety.

Moreover, the Spent fuel Assemblies stored temporarily for cooling may have to be transported either to reprocessing facilities or to interim storage facilities before direct disposal; it is the reason why the retrievability, including or not transportability of the proposed systems, is often specified by the Utilities for the design of their Storage systems and sometimes by law.

This paper shows on examples developed within companies of AREVA Group the key parameters and elements that can direct toward the selection of a technology in a user specific context.

Some of the constraints are ability to dry store at once a large number of spent fuel assemblies, readily available, on a given site. No urgent need for further move of the fuel is foreseen.

Then clearly a Vault Type Storage system developed and implemented by SGN is an excellent solution: It combines passive safety with immediate large capacity, which allows quick amortization of fuel receiving equipment. In addition the versatile storage position can easily accept in the same facility different fuel types, and also intermediate and High Level Waste. This is the reason why a vault system is often a preferred solution for a long-term dry interim centralized storage, for a multiplicity of spent fuel. It can be also a choice solution when the ISFSI stands on a site that is dedicated permanently to many different nuclear activities.

In most cases, the producers of spent fuel require a large capacity that is cumulated over many years, each reload at a time. Then the key criterion is maximum modularity.

Furthermore, the up front capital costs requirement for this type of solution is minimal, so depending on the chosen discount rate of the investor, they have an additional attraction. Those smaller modules allow to change course in back end policy more easily.

Priority of modularity yields two other solutions, dual-purpose metal casks of the TN24™ family or dual purpose or single purpose concrete shielded welded canisters such as NUHOMS®. These solutions, implemented by COGEMA LOGISTICS, TRANSNUCLEAR Inc. and FRAMATOME-ANP, are very flexible and have been adapted also to quite different fuels.

Among what influences the choice, we can consider:

- In favor of metal casks :
  - Minimal ancillary equipment.
  - Ready to move to final or centralized repository or reprocessing or other ISFSI.
  - Compact systems.
  - Easy rearrangement.
  - Easy handling.

- In favor of concrete shielded canisters based systems :
  - Economics when initial quantity is sufficient to spread out up front equipment.
  - Significant cost – Shielding advantage.
  - Easy local production of the relatively light canisters.

Both approaches, when transportable, are also a factor for public acceptance because of the non-permanent characteristics and because transport licensing refers to internationally recognized rules, standards and methods.
INTRODUCTION

Defining a back end policy is a challenging question to which there can be a combined array of answers depending on such basic questions like:

Who are we? An electricity producer? An agency in charge of a country’s long term back end management policy? Are my goals short or long-term?…

Clearly decision-makers in terms of back end policy for spent fuel, and more specifically in term of interim storage, can work on the subject from many perspectives which will in their turn evoke diverse choices or a combination of such choices.

The Areva Group has the unique feature of having developed techniques and solutions that cover the full spectrum of state of the art interim storage technology:

- Pool storage followed by reprocessing and recycling and immobilization of the long lived actinides
- For dry storage of spent fuel
  - vault type systems of the Cascad type
  - dual purpose (i.e. transport and storage) metal casks of the TN 24™ family
  - concrete shielded welded canisters (NUHOMS®)

The present paper will not dwell on the well-known comprehensive and integrated system that reprocessing offers, and rather concentrate on dry storage. After describing succinctly the features of each system, we shall discuss approaches and reasoning that orient chosen combination of storage systems.

The main features of our dry storage systems:

- A multiple containment barrier.
- Passive cooling, while the Fuel Assemblies are stored in an inert atmosphere and under conditions of temperature preventing from the degradation of rod cladding.
- Sub-criticality meeting ICPR 60 requirements as well as all applicable regulations (including severe weather conditions and earthquake).
- Safe handling operations.
- Future decommissioning of the facility through design optimization.
- Construction and operating cost-effectiveness.
**THE CASCAD VAULT SYSTEM**

The design comprises 2 main facilities: The unloading unit and the interim storage modules.

Containment is ensured by a double barrier:

- The first barrier is formed by the canister, in which the fuel elements are accommodated. The canister is inerted, tightly sealed and checked for integrity.
- The second barrier is made by the leaktight well into which the canisters are introduced.

**CASCAD SCHEMATIC**

The unloading unit

This unit offers maximum flexibility, accommodating all types of casks and fuel element and HLW as well. The design of this unit is based on T0 spent fuel dry unloading facility of the COGEMA-La Hague Plant. Since 1986, T0 has unloaded more than 13,000 MTU of PWR and BWR.

In the handling cell, spent fuel is inserted in canisters dimensioned and adapted to the fuel to be stored, irrespective of their dimensions or nuclear properties -residual- power, enrichment, etc…). After the interim storage period has elapsed, this unit also serves to remove the fuel canisters to their final destination. This operation requires no complementary installation.
The interim storage modules

These modules are built and added as the need arises. The fuel canisters are transferred from the unloading unit to the modules by means of a shielded transfer equipment or a crane.

The fuel canisters are stored in a concrete structure, which protects both personnel and the public against radiation, but also the fuel against external phenomena, such as earthquake, aircraft crash explosion, etc…

CASCAD VAULT TECHNOLOGY WORLDWIDE:

The reference facility: CASCAD, Cadarache, France:
Cascad, located on the Cadarache site (France), has been operating since 1990, for a storage period of 50 years.

Fuel stored in this facility originates from the CEA (French Atomic Energy Commission) research reactors and, in particular, from the Brennilis EL 4 Heavy Water Reactor as well as spent fuel from the French Navy.

The cooling air, which enters the bottom of the wells is heated along the wells and discharged to the atmosphere through a stack.

Other facilities: EVSE, R7, T7, AVM, TOR

On the COGEMA-La Hague site, the vitrification of fission products generated by reprocessing and associated glass canister storage takes place in the R7 facility for the UP 2 plant and in the T7 facility for the UP3 plant. These facilities were respectively put into operation in 1989 and 1992.

To increase the overall storage capacity, the EVSE facility (extension of glass storage for T7) was built and commissioned in 1995.

In the EVSE facility, the released heat is removed by natural convection. A liner around each well forms a double jacket and the cooling air circulates in the annular space thus formed. The leaktight well in which canisters are inserted provides the 2nd containment barrier.
AVM

Like R7 and T7, AVM is a vitrification facility with an interim storage for canisters, located at Marcoule (France). It has been commissioned in 1978.

TOR

TOR Facility, also in Marcoule, was commissioned in 1986 for the reprocessing of FBR fuel from Phenix. The fuel elements is unloaded under dry conditions and transferred to storage pits, cooled by forced ventilation.

The Habog facility, Nederland:

Final waste resulting from reprocessing of Deutsch fuel from Borssele and Dodewaard as well as HEU reactor fuel (Petten and Delft) and research center waste (from Petten) will be stored for 100 years in Habog, a facility built by SGN and based on the Cascad concept.

The design complies with the American standard ANSI-ANS 57-9 rules and specific events like flooding, earthquake, aircraft crash (F16-A Falcon Fighter), pressure wave resulting from external explosion and whirlwinds (velocity 125 m/s) have been considered.

The certificate of provisional acceptance was given to SGN on July 1st, 2003 and the official inauguration took place on September 30, 2003.

Habog, a new multi-purpose storage facility is ready to start-up - 2003
DUAL PURPOSE CASKS TN™ 24 FAMILY

The TN™ 24 concept is precisely adapted to the Transport and Storage of a wide range of fuel for both PWR and BWR types.

DESIGN BASIS

The casks belonging to the TN™ 24 Family are basically constructed as follows:

- The basic structure is a thick steel cylindrical forging with a welded on forged bottom and one or two bolted forged steel lids equipped with metallic gaskets. These three main components make up the containment. The thick steel forging provide the main gamma shielding,

- surrounding the cylindrical cavity, a resin layer encased in a smooth steel outer shell acts as neutron shielding,

- inside the cylindrical cavity, a boron aluminum basket supports the Spent Fuel Assemblies and guaranties their subcriticality; it consists of mechanically assembled partitions in boronated aluminum defining an array of cells, one for each fuel assembly,

- trunnions are attached to this structure for handling, tilting and tie down,

- a set of shock absorbing covers is fitted to the cask for transport operation, as well as lateral impact limiters.

- The possibility of easily adapting the boron content in the aluminum basket allows to consider increasing U-235 initial enrichments (Cf. Table),

- As shown in the next picture, the TN™ 24 family covers a wide range of dimensional characteristics coping with heterogeneous fuel types and different nuclear facilities.
<table>
<thead>
<tr>
<th>Cask</th>
<th>No of assemblies</th>
<th>Max Burn up (MWd/tU)</th>
<th>Cooling time (years)</th>
<th>Max Enr. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN™ 24 D</td>
<td>28 PWR</td>
<td>36 000</td>
<td>8</td>
<td>3.4</td>
</tr>
<tr>
<td>TN™ 24 DH</td>
<td>28 PWR</td>
<td>55 000</td>
<td>7</td>
<td>4.25</td>
</tr>
<tr>
<td>TN™ 24 XL</td>
<td>24 PWR</td>
<td>40 000</td>
<td>8</td>
<td>3.3</td>
</tr>
<tr>
<td>TN™ 24 XLH</td>
<td>24 PWR</td>
<td>55 000</td>
<td>7</td>
<td>4.25</td>
</tr>
<tr>
<td>TN™ 24 SH</td>
<td>37 PWR</td>
<td>55 000</td>
<td>5</td>
<td>4.25</td>
</tr>
<tr>
<td>TN™ 24 G</td>
<td>37 PWR</td>
<td>Average 42 000</td>
<td>10</td>
<td>3.8</td>
</tr>
<tr>
<td>TN 52 L</td>
<td>52 BWR</td>
<td>53 000</td>
<td>mini 2,5</td>
<td>4.95</td>
</tr>
<tr>
<td>TN 68</td>
<td>68 BWR</td>
<td>40 000</td>
<td>10</td>
<td>3.3</td>
</tr>
<tr>
<td>TN 97 L</td>
<td>97 BWR</td>
<td>Average 26 000</td>
<td>10</td>
<td>3.95</td>
</tr>
<tr>
<td>TN™ 24 BH</td>
<td>69 BWR</td>
<td>50 000</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>TN 32</td>
<td>32 PWR</td>
<td>40 000</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td>TN 40</td>
<td>40 PWR</td>
<td>40 000</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td>TN 24™ P</td>
<td>24 PWR</td>
<td>33 000</td>
<td>5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**TN™ 24 Family**

A versatile design adaptable to various SFA characteristics

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**THE TN24 CASKS WORLDWIDE**

Delivered 15 years ago, the TN™ 24 P is the “eldest” cask of the TN™ 24 family cask. This cask has been used by USA Virginia Power and US DOE Idaho Falls National Laboratory. Since then more than 100 TN™ 24 units have been licensed for transport and storage in Europe, the USA and Asia as shown in the next Table.

<table>
<thead>
<tr>
<th></th>
<th>ORDERED</th>
<th>DELIVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>91</td>
<td>33</td>
</tr>
<tr>
<td>BELGIUM</td>
<td>41</td>
<td>29</td>
</tr>
<tr>
<td>SWITZERLAND</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>JAPAN</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>157</td>
<td>80</td>
</tr>
</tbody>
</table>
NUHOMS® CANISTER BASED SYSTEM

DESIGN BASIS

The NUHOMS® system provides a comprehensive technology to store and transport spent nuclear fuel. It has been optimized by standardization of design, fabrication, and operation.

The NUHOMS® system is canister based, utilizing stainless steel canisters as spent fuel waste package and horizontal concrete storage modules as storage overpacks. The canister is loaded, transferred to the storage module, and ultimately transported to a repository or interim storage facility by means of a transfer or transport cask.

CANISTER

The NUHOMS® dry shielded canister (DSC) consists of a stainless steel shell and end covers with a basket assembly which provides structural support and criticality control of the spent nuclear fuel assemblies.

The basket assembly design can be adapted to handle different types of spent nuclear fuel as shown in the next Table. Additionally, there are different basket designs for storage only and for the dual purpose systems. While the basket assembly can be varied, each separate basket is designed to fit into the standard canister configuration.
<table>
<thead>
<tr>
<th>Casks</th>
<th>No of assemblies</th>
<th>Max Burn up (MWd/tU)</th>
<th>Cooling time (years)</th>
<th>Max Enr. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUHOMS® 24 P</td>
<td>24 PWR</td>
<td>40 000</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>NUHOMS® 32 P</td>
<td>32 PWR</td>
<td>40 000</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>NUHOMS® 52 B</td>
<td>52 BWR</td>
<td>35 000</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>NUHOMS® 61 B</td>
<td>61 BWR</td>
<td>45 000</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>NUHOMS® 56 V</td>
<td>56 VVER</td>
<td>42 000</td>
<td>5</td>
<td>3,6 (U-235 equivalent)</td>
</tr>
<tr>
<td>NUHOMS® RBMK</td>
<td>95 RBMK</td>
<td>25 000</td>
<td>5</td>
<td>2,4</td>
</tr>
</tbody>
</table>

**Transfer Equipment**

Once the fuel is loaded and all draining, drying and sealing operations are completed, the cask is placed on its skid in a horizontal orientation. When the cask and its canister waste package is moved outside the reactor building there are no operations which require a heavy lift of the canister. The canister is transferred or retrieved from the cask to the storage module by means of a hydraulic ram, which pushes or pulls the canister out of or into the cask. The operations are simple and provide for an additional safety benefit by the exclusion of heavy lifts.

**Storage Module**

The NUHOMS® storage overpacks are concrete horizontal storage modules (HSM's) which provide the overpack for the canister in its storage mode. The storage module is designed to handle the standardized diameter canister and has the flexibility to accommodate different lengths. The HSM is designed as a stand alone unit consisting of two prefabricated pieces – a base unit (floor and walls) and a roof unit. These HSM's are transported to the site storage location and set in place. They can be arranged in various configurations to minimize the radiation dose associated with the site.

**Transport Cask**

The NUHOMS® dual-purpose storage and transportation cask utilizes the canister for its operations. This cask is also designed to be compatible with all NUHOMS® storage system components. This cask can be used for fuel loading and transfer operations, which places the canister into the storage module. The cask mates up with the storage module to allow for retrieval of the canister for shipment to another location – repository or interim storage facility.

**STANDARDIZATION AND FLEXIBILITY**

The NUHOMS® system uses standard product dimensions so that various spent fuel canister waste packages can be designed using the same transfer and transport casks, auxiliary equipment, and storage modules.
THE NUHOMS® TECHNOLOGY WORLDWIDE

We shall first display important parameters, then come back to address each of them.

The first array of parameters is comprised of the legislative and regulatory context, its possible foreseen evolution, and the identity of the decision-maker:

<table>
<thead>
<tr>
<th>Client</th>
<th>NPP</th>
<th>System</th>
<th>Loaded</th>
<th>Delivered</th>
<th>Ordered</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP&amp;L</td>
<td>Robinson</td>
<td>NUHOMS®-7P</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Duke</td>
<td>Oconee</td>
<td>NUHOMS®-24P</td>
<td>57</td>
<td>65</td>
<td>84</td>
</tr>
<tr>
<td>BG&amp;E</td>
<td>Calverts Cliffs</td>
<td>NUHOMS®-24P</td>
<td>33</td>
<td>34</td>
<td>56</td>
</tr>
<tr>
<td>Toledo Ed.</td>
<td>Davis-Besse</td>
<td>NUHOMS®-24P</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>GPUN</td>
<td>Oyster Creek</td>
<td>NUHOMS®-52B</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>SMUD</td>
<td>Rancho Seco</td>
<td>NUHOMS®-24PT</td>
<td>0</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>SCE</td>
<td>SONGS1</td>
<td>NUHOMS®-24PT1</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>PP&amp;L</td>
<td>Susquehanna</td>
<td>NUHOMS®-52B</td>
<td>8</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>DOE INEEL</td>
<td>TMI-2</td>
<td>NUHOMS®-12T</td>
<td>6</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>ARMATO MENERGO</td>
<td>Medzavior</td>
<td>NUHOMS®-56V</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>CH.NPP</td>
<td>CHERNOBYL</td>
<td>NUHOMS® RBMK</td>
<td>-</td>
<td>50</td>
<td>232</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>126</td>
<td>173</td>
<td>495</td>
</tr>
</tbody>
</table>
Key questions are:

**Legislative and regulatory context**

1. What may we do (reprocess, store at reactor, send to a centralized interim storage facility)?
2. What can be licensed?
3. What is the timeframe involved from decision to commissioning?

**Identity of the decision maker**

4. What is my mission? What are my core competencies?
5. What alternative do I possess?
6. Whence come my resources for that job?
7. How does my choice influence my longer-term costs?
8. Must my decision involve elements of local production?

**The second array of parameters may be more site specific**

9. Is changing course in the medium term valuable to me?
10. What quantities/qualities are involved?
11. How much space do I have?
12. What are my handling capabilities?
13. When is my need?
14. What is the quality of the relationship to the neighborhood?

**Significance of the parameters for exercising a choice**

**Legislative and regulatory context**

1. What may we do (reprocess, store at reactor, send to a centralized interim storage facility)?

In some countries, like Germany, the recent evolution of the legislative context makes it a priority to avoid transport of spent fuel and facilitates at reactor interim storage. This means that the chosen system should be acceptable for storage on site, consider future unavailability of the NPP for casks reopening, and therefore leads to a dual purpose system such as the TN 24™ E chosen by E.ON Kernkraft and EnBW.

2. What can be licensed?

Depending on regulations, impositions such as aircraft crash impact, acceptability of a mode of subcriticality justification or not can influence chosen technologies: for instance the boron credit used in the USA to justify subcriticality upon loading, plus moderator exclusion thereafter may create difficulties if one also wishes to have the system licensed for transport.

©COGEMA LOGISTICS, FRAMATOME ANP, SGN
Radioactive Waste and Spent Fuel Management” International Conference, 6-8 November 2003, Bulgaria
Typically, some storage only systems that are presently implemented in the USA may require substantial additional effort if they have to be moved off site. This is why today, most procurement of NUHOMS® system chose to go for the transportable version.

3. What is the timeframe involved from decision to commissioning?

Choosing a system that is already licensed (possibly with a different authorized content) by the authority in charge means additional confidence on ability to be licensed and timeliness of said license. This by no means precludes other choices, but precautions must be taken when the licensing route is being chosen, so that overall time schedules are compatible.

Identity of the decision maker

4. What is my mission? What are my core competencies?

In the United States, responsibility for used fuel rests with the US DOE, who collects $0.001 per produced kWh to cater to this responsibility. In other words, US spent fuel producers are in the business of generating electricity or doing research, and wish to go for interim storage only to be able to hold on their operation until DOE does indeed take over the spent fuel.

Conversely in Switzerland (ref.6) the four operators of NPP have regrouped their effort to create ZWILAG, a centralized interim storage facility, because it is their part to cater to the fuel as long as the geological disposal (or another solution) is not available. They combine this approach with reprocessing, for instance at the COGEMA LA Hague plant, and receive in return dual-purpose casks loaded with concentrated vitrified high level waste. So they chose to delegate the core competency of dealing with dry storage on the operator they created.

In the HABOG facility, COVRA, based on its mission to cater to nuclear waste or spent fuel generated in the Netherlands, has to be an operator of that facility that can accept multiple shapes and forms of radioactive material in a very compact format. That brought them to chose the flexibility of a vault system, able to take in the same facility HLW, Spent Fuel from power and research reactor

5. What alternative do I possess?

A multi NPP utility may want to combine flexibility of optimizing the occupation ratio of their decay pool by performing transshipment between pools: in that case it may be an adequate choice to have a fleet of dual purpose casks first used for transport and then for interim storage.

In other cases, the alternative may be to combine reprocessing and at-reactor interim storage. In other cases again, time can be a leading concern, and short lead time items such as NUHOMS® can be the solution.

6. Whence come my resources for that job?

The US utilities, for instance, just like the Spanish ones, have no real concern on volume of spent fuel when considering back end solution, since a state entity is in charge of taking over their spent fuel in exchange for a fee based upon energy production. In that case, resources should be kept to the minimum necessary to keep the fuel pool with full core reserve since disposal of fuel is already taken care of. They generally chose the simplest equipment like NUHOMS®.
If conversely the utility pays in proportion of volumes of SF, then it has an incentive of both raising burn-up and keeping a very dense interim storage solution, such as metal casks, that also cater well to issues linked to high burn-up.

If large quantities of fuel are immediately available, choice of a vault system will be the prime choice for scale savings.

7. How does my choice influence my longer-term costs?
In line with the preceding point, the question of who is in charge and who is bearing costs for the longer term may influence choices:
- As long as the NPP is running, the additional operational costs and concerns about operating an ISFSI are relatively small. Once no pool remains available, then transportability becomes a question of prime importance, since remedying a defect may involve shipping the system away. In addition, there may a significant premium in making sure that fuel is removed then stored outside the NPP soon after it reaches its final shutdown.

8. Must my decision involve elements of local production?
There are many advantages of producing elements of a dry interim storage system locally
- Qualification of suppliers for the longer term
- Public Acceptance aspect of having a benefit for local economy
- Easier follow up by local competent authorities

For that purpose, a large part of the Cascad Vault system and of the NUHOMS® system are easier to transfer to local industry than heavy casks. The example of Chernobyl where all production is made locally is a strong point of the world's largest dry ISFSI.
The longer term also involves the decommissioning of NPP for at reactor storage, and the question may be what of the costs of operation and back up solution once the NPP pool is not available any more:
Vault systems and transportable systems are autonomous and provide solutions in such case. Storage only casks or canister systems are more problematic.

The alley of
FRAMATOME’s
Chernobyl NUHOMS®
Site specific parameters:

9. Is ability to change course in the medium term, valuable to me? 
The modularity and up front investments associated with the system are a key parameter to help answering that question: 

With dual-purpose metal casks, not only can the operator decide not to procure the next one, it could also use those delivered to ship the fuel elsewhere. The impact of short term change is harder for canister systems, since up front equipment can represent a sizable amount, unless it can be sold to another user. 

Vaults are of course committing the operator for a longer period before it becomes reasonable to change course. 

One may also observe that this parameter may also point to the advantage of choosing from day one a strategy involving transportable systems. This keeps open at all times reprocessing options, or facilitate using them in parallel. The TN 52 L dual purpose cask was developed and used in order to perform routine transport of BWR fuel to reprocessing plants then to store spent fuel at the Zwilag facility.

10. What quantities /qualities are involved? 
The inventory of spent fuel to be stored is of course another prime parameter in choosing a system. 

Large inventories make the up front investments for a vault system worthwhile: the system initial units represent an relatively large percentage of the overall costs, while actual storage space, especially for a large batch readily available, does not represent such a high contribution, when expressed in kg of heavy metal stored. 

Diversity of material and medium quantities can also justify the vault systems, that can offer different accommodation pits for different material under the same roof. 

The combination of distance and inventory is also to be pondered : investing in a cask transport fleet in order to feed the vault if different sites are involved may also be costly and involve issues of public acceptance. 

Small inventories, or progressively increasing inventory (i.e. a batch every year or so, corresponding to the reactor reload) may call for additional modularity such as that of dual purpose casks or concrete shielded canisters like NUHOMS®. Thus it is possible to spread out the investment, and to profit from the financial discounting rate that favor differed investments. 

11. How much space do I have? 
Footprint, space available are also influencing the choice of system : maximum density can be achieved by metal casks, irregular shapes of sites can be best occupied by casks and canisters systems, vaults prefer rectangular sites. The South California Edison ISFSI choose NUHOMS® among other things because it required a canistered system with strong seismic resistance combined with a small footprint compatible with their available space.

12. What are my handling capabilities? 
Metal casks are more competitive when they can maximize capacity and diameter that is also when they can be quite heavy: the TN™ 24 G cask weighs 135 tons. The issue of handling and bearing capacity within the facilities where the system will be loaded has therefore a strong
influence. In the case of the TN™ 24 G, it is the proper combination of size, mass and loading plans that authorized the loading of 37 PWR SFA per casks.

In canister based systems, the relative standardization of peripheral loading equipment create minimum and maximum performances for the systems in term of capacity.

Vault systems are relatively independent from these considerations, because they can always rely on a compatible transfer shuttle between NPP and storage.

13. When is my need?

This parameter is connected to the question of ability to get a license on schedule, of choosing or not to qualify a local fabricator, of operational issues linked with the NPP such as core and decay pool management, burn-up, contingencies etc.

There are two reference times:

First is time to initial loading on a new ISFSI, and this is relatively long and second is time to procure additional units.

These reference times are directly affected by necessity or not of new developments on the storage system itself, whether the license is generic or not, whether new investments for production are necessary or not.

The shorter possibility for initial loading is the dual-purpose metal cask. The shorter renewal time is the canister system case.

14. What is the quality of the relationship to the neighborhood?

As our Czech friends know well, neighborhood can be extended to neighbor countries, where any new development in the nuclear field is followed by intense anti activity from Austrians.

Then choices pertaining to references that are internationally accepted such as the IAEA recommendations for transportation of radioactive materials, may become important:

- they offer the fact that regulations are not a local choice, but the choice by experts coming from all horizons,
- they also pass the message that if the system is transportable, then it will not stay there forever.

The ability also to choose systems that can be seen elsewhere, discussed with other communities can be a parameter for choice.

**CONCLUSION**

Choosing a dry interim system technology is not an easy choice, it involves a combination of technological, political, licensing, policies parameter for which the answer has to be carefully built.

The ability to choose from organizations like AREVA that are able to display a complete range of solutions and services guarantees

- that one or another important parameter is not discarded for want of an adequate answer
- that altering course may receive an adequate support for that.
- that the long term maintenance of the chosen solution(s) in the medium long term is provided for.
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