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LATEST INNOVATIVE PACKAGING TYPE B CONCEPTS DEVELOPED BY CEA AND TN INTERNATIONAL FOR FRESH/IRRADIATED FUEL AND WASTE TRANSPORTATION.

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ABSTRACT

Looking for the renewal of the Cask Fleet for CEA for R&D applications and Reactors needs, CEA and TN International have jointly developed new concepts of packaging type B according to IAEA 96 regulation using:

- Double containment barrier for Fresh/irradiated Fuels transportation.
- Simplified concept for on site multi-content transports.

This paper describes the key design aspects of the following third new concepts.

FS110: This cask will comply with the following key requirements

- Intermediate storage for Fresh fuels on manufacturing plant, 200 casks foreseen.
- Transport by batch of Fresh fuel between manufacturing plant and Reactors.

In order to reach the previous requirements, the design has been made in separating the function of intermediate storage from the function of transport, using a double containment barrier with:

- One Inner pack designed for stacking with seismic accelerations. 200 Inner packs will be manufactured.
- One over pack for transportation on road by batch between facilities. 20 Over packs are sufficient for cover the transport's needs.

IR 800: **This cask has been designed for:**

- Spent fuels from French navy needs
- Unloading under water of fuel at the pool.
- Capacity of half core transportation (8 Fuels Assemblies/cask)
- Weight of the loading transport system less than 40 Tons in order to reach the European regulation for legal weight transport.

The design of the concept is based on a double containment barrier in order to transport the 8 enriched used fuel assemblies within the 40 tons for the loading transport system.

Multi-content shell for on site transportation:

- On site transport of older casks which no more meet the transport regulation (leak tightness and mechanical behavior).
- On site transport for waste (Concrete or not drums, radiolysis waste with low level of irradiation)
- Low weight of empty shell, yet type B package.

The package has been designed in maximizing the inner volume:

- Weight capacity of 6 tons for a weight of empty packaging of 3 tons.
- Strict limitation of type of materials used for manufacturing (essentially stainless steel and phenolic foam)
- Easy use on facilities (short opening and closing time)
- Easy decontamination
- Few maintenance operations

These innovative new concepts have a high potential of use according to the needs of nuclear facilities, reactors or plants in the world.
After manufacturing, these casks will joint the common fleet between CEA and TN International in order to offer to the customers, the possibility to rent this fleet for their own business, therefore decreasing designing and cask operating costs.

INTRODUCTION

Looking towards the renewal of the Cask Fleet for CEA R&D applications and Reactor needs, the CEA and TN International have jointly developed new concepts of packaging type B according to IAEA 96 regulation using:

- Double containment barrier for Fresh/Spent Fuel transportation.
- Simplified concept for on site multi-content transports.

This paper describes the key design aspects of the following three new concepts:

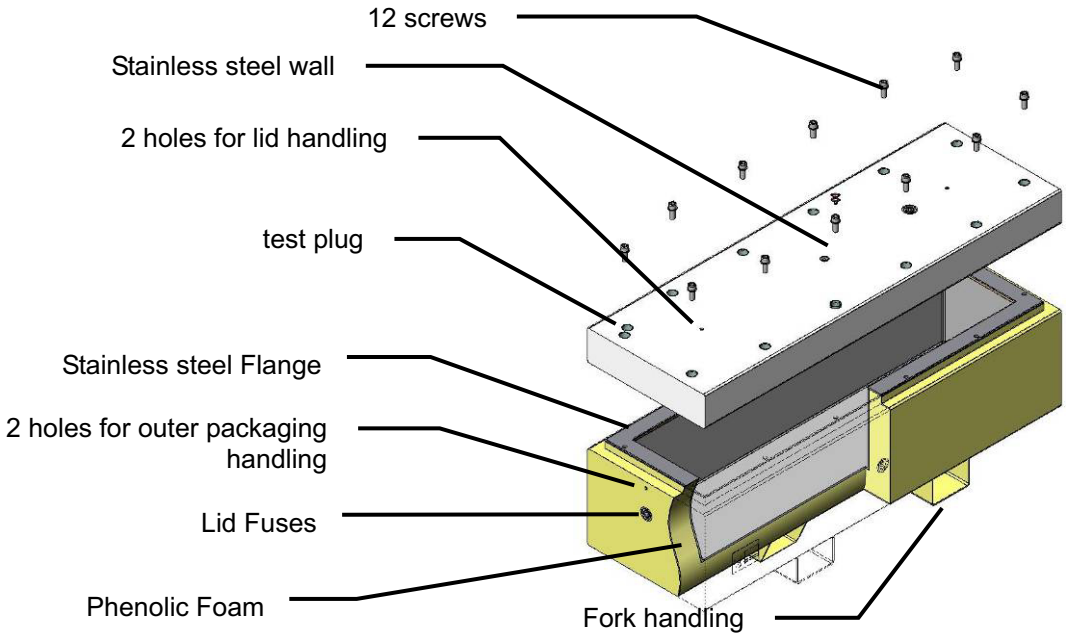
FS110, IR 800 and transport shell, latest 3 new models for Fresh or irradiated fuel and Waste transportation.

FS110 packaging:

1. Package Design Criteria: This cask will comply with the following key requirements

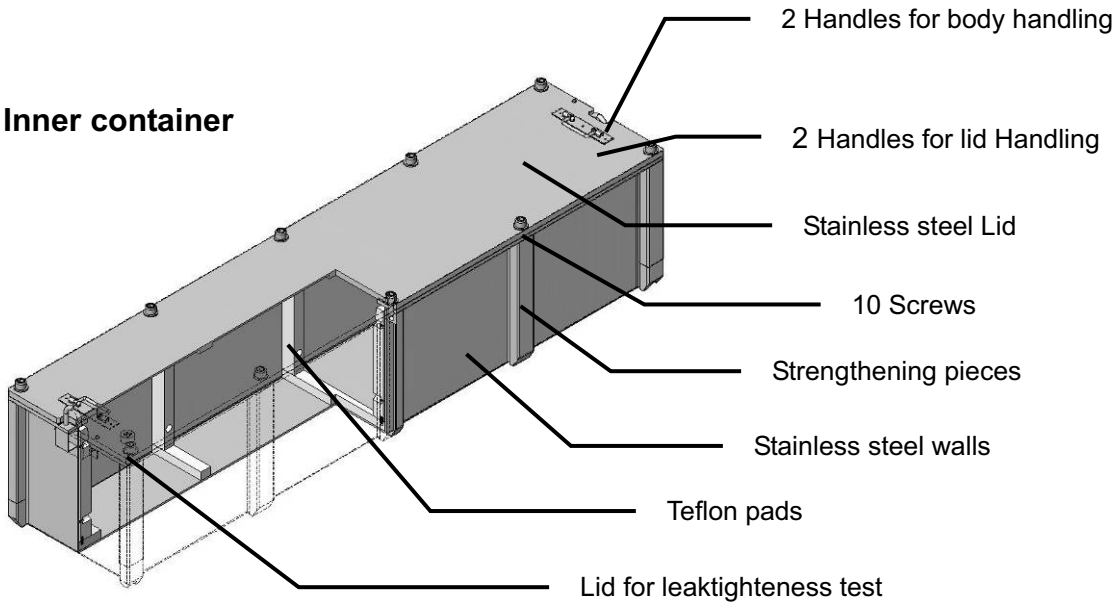
- Content : Fresh fuel such as plate, Plate Bundles or Fuel Bundles for French Navy Needs
- Intermediate storage for fresh fuel at manufacturing plant, 200 casks foreseen.
- Transport by batch of Fresh fuel between manufacturing plant and Reactors.
- Ruin of content as assumption in case of drop test for criticality calculations. Design with double containment required.
- Type 2F Package (On site transport, < 100 A2) as defined in the TS-R-1 Regulations for the Safe Transport of Radioactive Material 2005 edition (ST-1, revised). The package must be easily decontaminable.

2. Description of the FS110



Outer packaging

Inner container



The FS 110 packaging with a total gross weight of 840 Kg and the main dimensions of 1919 x 733 x 630 mm consists of an outer packaging and an inner container. Both inner container and outer packaging are waterproof in order to avoid taking into account flood water in the criticality calculation.

- Inner container

    - The Inner container consists of stainless steel walls with pads to receive the content device. The inner container is closed by a lid with 2 O-ring gaskets and test plug for leaktightness test.
    - Strengthening pieces are welded outside the cavity in order to reinforce the structure of the inner container during stacking operations (up to 5 inner containers can be stack).
    - Characteristics of inner container are:
        - Inside dimensions : 318 (h) x 228 (w) x 1510 (l) mm
        - Outside Dimensions : 380 (h) x 373 (w) x 1655 (l) mm
        - Total weight : 170 kg

- Outer packaging

    - The Outer packaging which provides for the inner container protection against mechanical and thermal (fire) impacts under accident conditions consists of a rigid rectangular stainless steel box with phenolic foam inside both walls which is closed on top by a lid fixed with 12 screws. The outer packaging is closed with a lid with gaskets and a plug test allowing leaktightness testing
    - Two fork holes allow handling on site the FS 110 with a forklift easily.
    - The outer packaging can not be stacked on one another.
    - Characteristics of outer packaging are:
        - Inside dimensions: 385 (h) x 384 (w) x 1673 (l) mm
        - Outside Dimensions: 733 (h) x 630 (w) x 1919 (l) mm
        - Total weight: 670 Kg
        - Maximum FS110 loaded weight: 1 200 Kg

3. Schedule

Design: Done
Drop Test: Will be conducted end of summer 2007 at the TN International facility
Agreement expected: 2008
Manufacturing foreseen: 2008-2009
First loaded transports between facilities scheduled in 2009

4. conclusion

Using outer packaging for transport and inner container for on site storage and conditioning permits to save a lot of money (only 20 outer packaging for 200 inner containers instead of 200 full packaging). The design of the FS 110 could be used for many types of fuel or rods stored with easy handling and use.

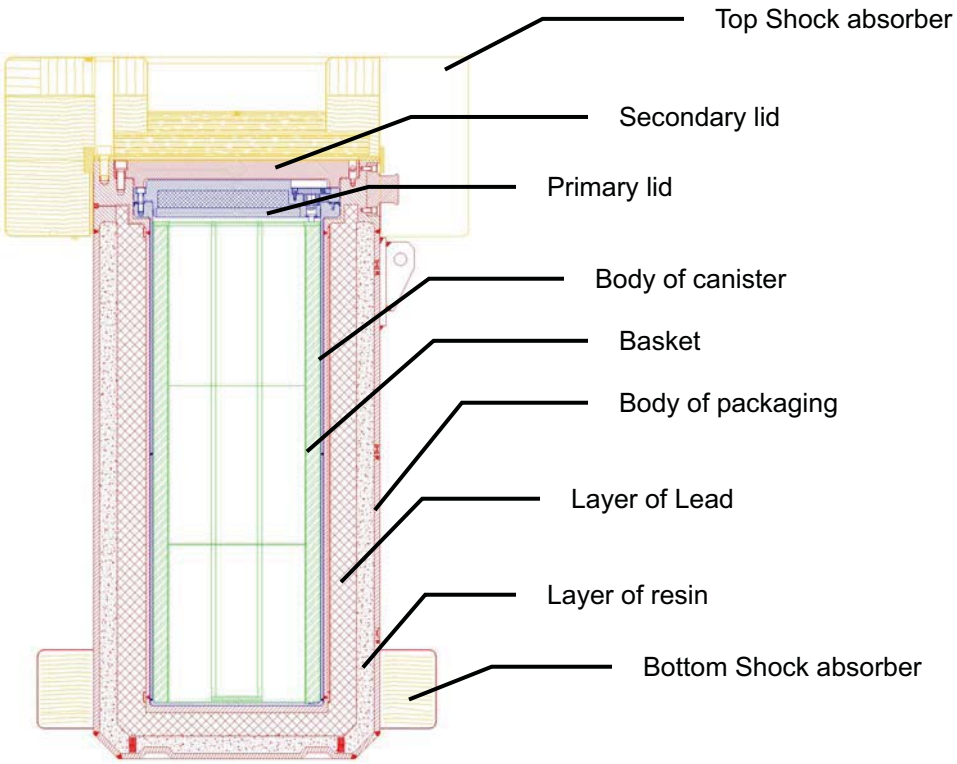
IR 800 packaging:

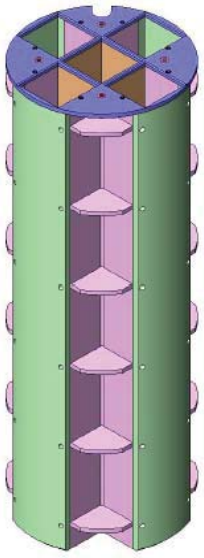
5. Package Design Criteria :This cask has been designed for :

- Used fuel from French navy needs
- Unloading under water of fuel at the pool.
- Capacity of half core transportation (5 to 6 Fuel Assemblies/cask)
- Type B Package as defined in the TS-R-1 Regulations for the Safe Transport of Radioactive Material 2005 edition (ST-1, revised). The package must be easily decontaminable.
- Weight of the loading transport system should be less than 40 Tons in order to reach the European regulation for legal weight transport.

The design of the concept is based on a double containment barrier in order to transport enriched used fuel assemblies within the 40 ton limit for the loading transport system.

6. Description of the package





Basket 5 lodgements

The IR 800 packaging consists of 6 main parts: The body of canister and primary lid corresponding to the first containment barrier, the body of the packaging and the secondary lid corresponding to the second containment barrier, and the top and bottom shock absorbers.

The body of the canister consists of stainless steel confinement walls in order to:

- Assure sub criticality of fuel bundles during normal and accident transport conditions;
- Assure containment of fuel bundles with the primary lid.

- The primary lid consists of stainless steel internal plate, layer of lead and external stainless steel plate blocked on the body by screws in order to :

  - Assure tightness of primary containment envelop with the body canister ,
  - Resist for mechanical strength in normal and accidental transport conditions as defined in' AEA <TS-R-1 edition 2005> regulations and in order to comply with the thermal calculation assumption, containment release, dose rate and safety analysis of the packaging.
  - Limit the axial dose rate in normal and accident transport conditions.
- The body of the packaging consists of a stainless steel envelop, a layer of lead, a layer of resin , an external stainless steel envelop and copper fins facilitating evacuation of the heat: Functions are:
  - Hold the canister with fuel bundles in normal and accident transport conditions.,
  - Resist to mechanical stress in normal and accidental transport conditions as defined in IAEA <TS-R-1 edition 2005> regulations and in order to comply with the thermal calculation assumption, containment release, dose rate and safety analysis of the packaging,
  - Dissipate the thermal power in normal transport conditions and protect fuel bundle against high temperature from fire,
  - Reduce the dose rate all around the package,
  - Assure confinement of fuel bundle with the secondary lid,
  - Assure sub criticality with the canister,
- The secondary lid consists of stainless steel material with the following functions:
  - Assure tightness of secondary containement envelop with the body of the packaging,
  - Resist for mechanical strength in normal and accidental transport conditions as defined in by l'IAEA <TS-R-1 edition 2005> and in order to comply with the thermal calculation assumption, containment release, dose rate and safety analysis of the packaging,
  - Limit axial dose rate in normal and accidental transports conditions.
  - assure sub criticality with the canister,
- Shock absorbers consist of wood (red cedar, balsa and plywood) inside stainless steel envelop restricting accelerations in normal and accidental transport conditions.

Total weight of these six elements is close to 23 600 kg

- Two types of canisters have been developed with 5 or 6 lodgements.

7. Drop test

The development of the IR 800 included three half-scale test campaigns performed at AREVA TN International drop test station in the south of France.

After each series of tests, the successful leaktightness of the envelops was checked.

A total of 16 drop tests have been conducted including 7 puncture tests.

Configuration before drop test at TN International' test facility in Laudun (France)

8. Manufacturing

Two sets of IR 800 have been manufactured, using MMC plates for the both baskets. This material consists of aluminium with up to 25% of B4C for criticality shielding. This material was developed by TN International in order to get more efficient neutron absorption material for the new casks to be developed in the following years.

9. Licensing

IR 800 is licensed under type B Package

10. Conclusions

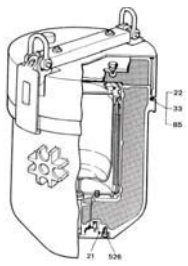
First campaign of transports has been successfully performed during the beginning of 2007. IR 800 cask is ready now to go in service, replacing the old IU15 used for 20 years.

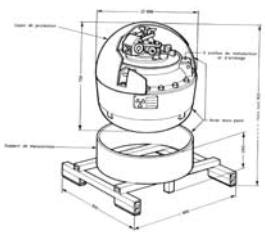
FAR Shell packaging:

11. **Multi-content shell for on site transportation:** Package Design Criteria**:**

- On site transport of older casks no more meeting the present transport regulation (leak tightness and mechanical behavior).
- Waste on site transport (Concrete or waste drums, radiolysis waste with low level of irradiation)
- Low weight of empty shell,
- Easily adaptable for other contents changing internal spacer
- Leaktightness with double gaskets for content confinement
- Maximizing the inner volume of the packaging
- **6 tons** weight capacity f**or a weight of empty packaging of 3 tons**.
- Strict limitation of types of materials used for manufacturing (essentially stainless steel and phenolic foam)
- Easy use on facilities (short opening and closing time)
- Few maintenance operations
- Easy decontamination

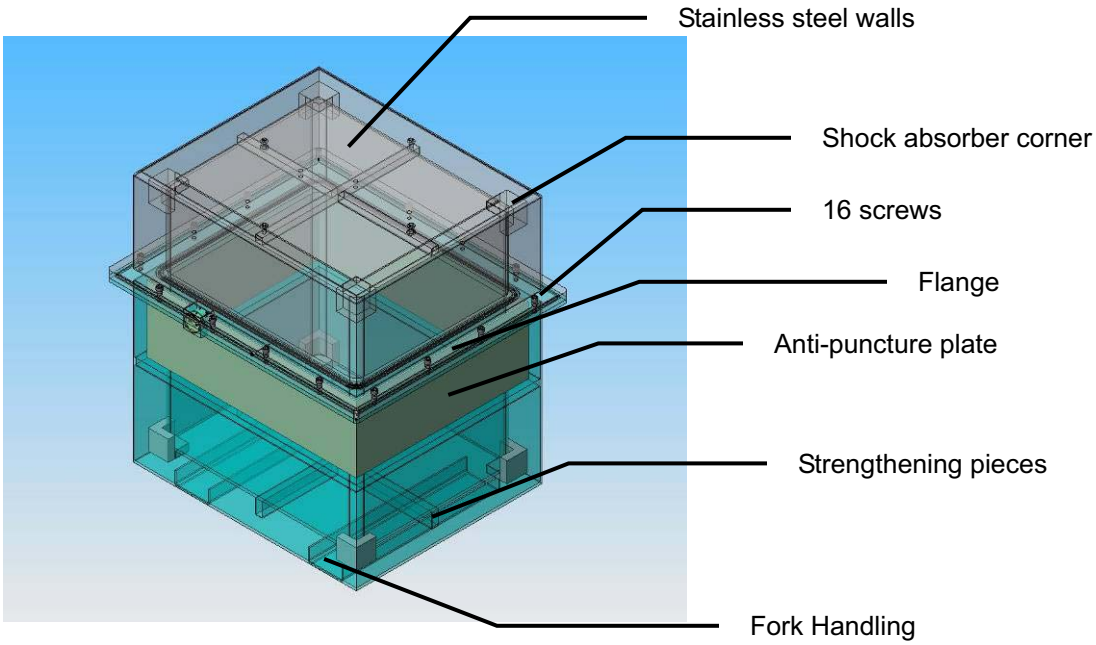
Examples pf content transported with the FAR Shell





12. Description of the package

The Multi-content shell for on site transportation called « FAR SHELL » consists of a rigid rectangular stainless steel box in order to increase the inner volume. Far Shell is constituted by two half shells with:



- An external and internal stainless steel shell
- A 100 mm thick phenolic foam layer between external and internal shell.
- A flange to link internal and external plates.
- Four Aluminium shock absorbers inserted on each corner of the FAR Shell.
- 16 M30 screws to close the Far Shell through the flanges with both elastomere gaskets and a test plug in order to perform leaktightness tests before operation.
- Two nozzles closed by plugs for internal atmosphere checking or inert gases injection
- An Upper flange to avoid cutting of the strengthening screws.

Between internal and external plates of the bottom Shell:

- A strengthening cross on the bottom.
- An anti-punching aluminium plate for puncture test.
- A fork lift hold for on site handling operations.

Between internal and external plates of the upper Shell:

- A strengthening cross for mechanical behaviour
- An anti-punching aluminium plate for puncture test.
- 4 embossings with M12 holes for handling of the upper Shell.

13. Drop tests

Drop test with leaktightness tests have been successfully performed at the TN International Laudun facility during 2006 fall. 9 drops with 5 puncture tests were necessary. No major deformations have been induced by the puncture tests or 9 meter drop tests. Strengthening cross, anti-punching aluminium plate and flange have perfectly resisted to all the stresses.

14. Licensing

Licensing of the FAR Shell is expected beginning of 2008.

15. Conclusions

FAR Shell is interesting for on site transfer due to the weight content which is the double of the unloaded weight of the empty Shell. Cost of manufacturing will be less expensive thanks to the limited materials involved and the simplified design of the FAR Shell.

CEA and TN International are developing an on road Type B version of the FAR Shell called “THE MUST” for Multi Used Shell Transports, expected in 2009.

MAIN CONCLUSION

These innovative new concepts have a high potential of use according to the needs of nuclear facilities, reactors or plants all over the world.
After manufacturing, these casks will join the common fleet between CEA and TN International in order to offer the customers, the possibility to rent this fleet for their own business, therefore decreasing designing and cask operating costs.