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TN INTERNATIONAL'S NEW CASKS: DESIGNING FOR THE ENVIRONMENT

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Abstract :

Environmental protection has become an integral part of the entire cask life cycle:

- Design and Fabrication
- Transportation
- Loading, Unloading and Operation
- Maintenance, End of Life Cycle and Decommissioning

Three new environmentally-friendly cask concepts were developed: the MX6, the TN112 and the multi-purpose shell. The eco-design approach was used to reduce their environmental impacts and address environmental issues such as waste generation and management, greenhouse gases linked to transportation, and scarcity of raw materials, all while improving operating performance. The result is greater responsiveness to the customer and a more comprehensive approach to potential regulatory changes.

The cask design optimizes all of the impacting factors, such as raw materials quantity, radiological protection capacity, and the use of more environmentally-friendly materials and fabrication processes.
To illustrate, the new MX6 concept may be compared to the standard FS65 concept.
In the area of Design and Fabrication, the MX6 requires fewer raw materials and can lower the cask weight/transported assembly weight ratio. An adjustable basket concept was developed.
. The new cask is also more effective in terms of radiation protection as a result of improved materials performance.
. In the area of fabrication, all waste is transferred to suitable processing systems that promote recycling.
In the area of Transportation, shipments are reduced by 33%, thus reducing diesel fuel consumption and greenhouse gas emissions.
Also, in the area of Operations, the amount of waste generated per assembly shipped is minimized, as are the number of operations and the time spent on them by the operators.
In the area of Maintenance and Decommissioning, extensive, time-consuming maintenance operations are minimized, as is the waste generated by them.

The TN112 cask reduces exposure by 15%, uses fewer raw materials, and has a faster turnaround time due to optimized tooling.

For waste subject to radiolysis, irradiators and discontinued casks, attention focused on limiting the use of complicated materials and rare woods. Keeping the cask simple reduces the number of maintenance, decontamination and decommissioning operations to be performed later. This concept can be applied to a variety of contents.

Introduction :

Eco-design is a core component of AREVA's sustainable development policy. Having received ISO 14001 certification for all of its transportation operations and reviewed ways to reduce greenhouse gas emissions by reducing fuel consumption, the application of eco-design to all new cask concepts is one of the three environmental projects of AREVA's Logistics business unit: "from product design to product eco-design".

TN International conducted a preliminary study on this subject in 2005 to support decision-making in the choice of environmental improvement activities. The focus was the environmental impact study of two casks: the TN12/2 cask used to transport used or fresh fuel, and the LR65 tanker truck used to transport uranyl nitrate.
A method was proposed for comparing certain processes and previously defined lifecycle stages, based on three performance indicators: greenhouse gas emissions, raw materials consumption, and hazardous waste and effluent production.
Greenhouse gas emissions are linked to the consumption of energy in the form of electricity or fossil fuels. For the TN12/2, fabrication and transportation have comparable impacts in terms of GHG emissions, which are 100 times greater than for the other two stages. The fabrication processes with the greatest penalty are those involving production or metal forming: the fabrication of semi-fabricated steel products, forging, casting, machining and welding. For the LR65 as well, transportation is preponderant in terms of GHG emissions compared with maintenance or decommissioning.
In raw materials consumption, while the use of rare metals, wood and water is not negligible, the biggest impact comes from the consumption of fossil fuels. Transportation has a major impact for both casks. For the TN12/2, fabrication has an even bigger impact than transportation, mainly due to the consumption of fossil fuels during steel fabrication and forging.
In terms of waste and effluent production, the processes or stages with the greatest penalty are those that use products with a high chemical or radioactive component. According to the "Waste/Effluent" indicator, maintenance and decommissioning are 100 times more "impacting" than the other stages for both casks under study. The impact of decommissioning is due to the fact that the casks themselves become radioactive to varying degrees. The impact of maintenance is largely the result of effluent production during cask decontamination. For the TN12/2, fabrication processes such as dye penetrant tests or resin pouring can also have a significant impact.
When the annual impacts of both casks are compared, the impacts of the TN12/2 are greater than those of the LR65 at every stage (transportation, maintenance, decommissioning) and for each indicator. The same is true when major shared processes are considered individually (transportation over a given distance, decontamination, disposal), mainly due to the greater weight and degree of contamination of the irradiated fuel cask.

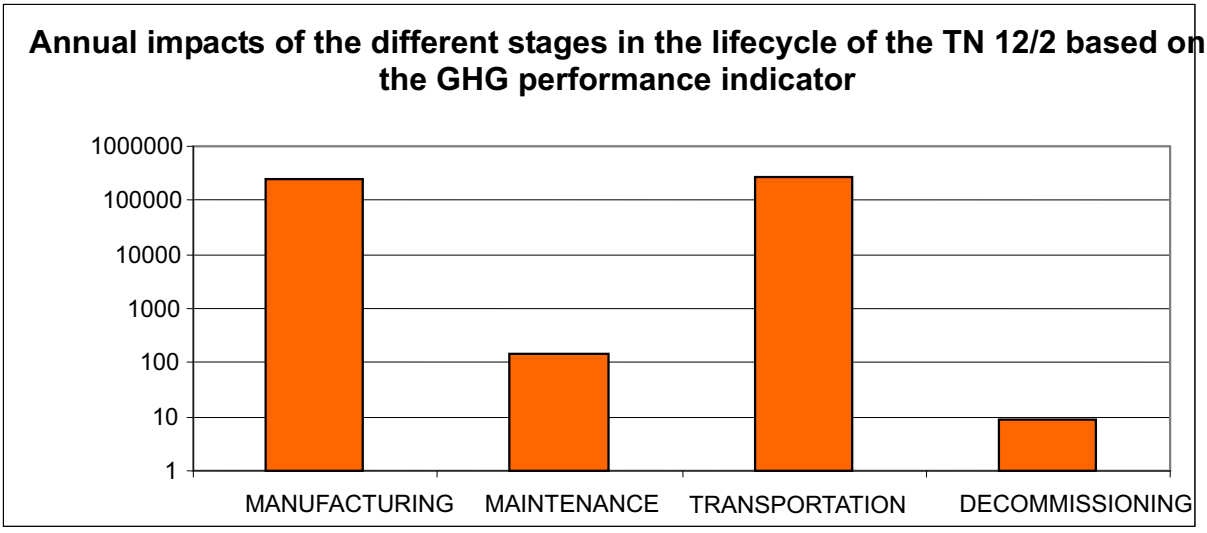
This preliminary study helped quantify the environmental impacts of two TN International casks over their lifecycles and pointed towards actions that can be taken at each phase in the cask lifecycle to mitigate those impacts. It gave a few leads for general improvements:

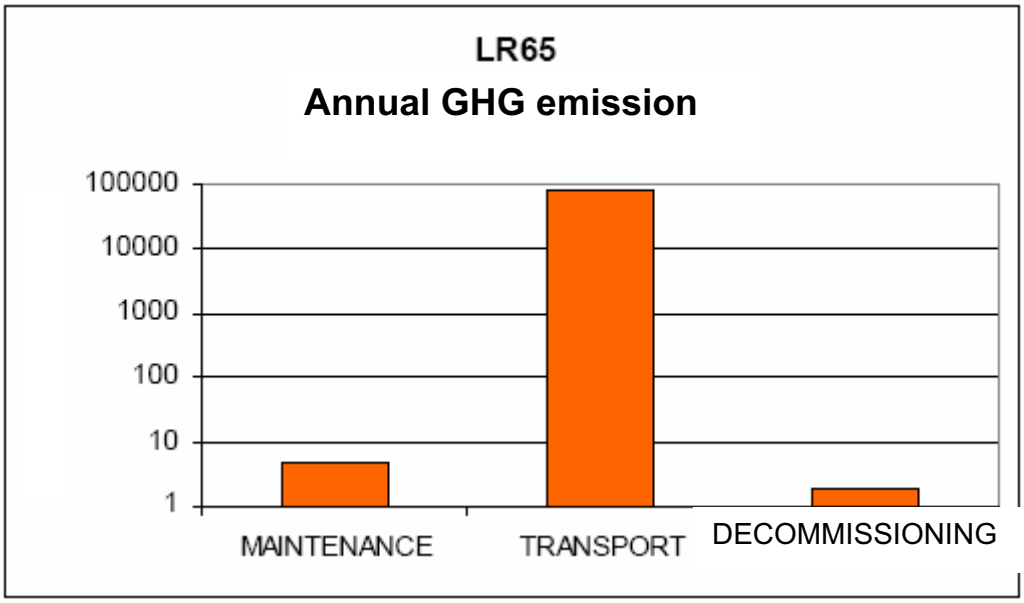
Fabrication: ***in the choice of steels (use of recycled steel, etc.) and the use of electricity-based processes to reduce greenhouse gases and raw materials consumption.***

Transportation: ***in the logistics of road transportation to reduce greenhouse gases and raw materials consumption.***

Maintenance: ***in designing the cask for reduced effluent and waste generation.***

Decommissioning: ***particularly in the choice of recycling channels to reduce waste, effluents and raw materials consumption.***





This supplements the previous study by adding as an objective the showcasing, both internally and externally, of the steps taken by TN International in cask design in recent years to improve environmental performance.

The generally recognized benefits of eco-design are:

- *Products that are generally cleaner*
  - Review of the different stages in the lifecycle
  - Decommissioning factored into the design
  - Maintenance optimized during design
- *A bottom line that is generally better*
  - Fewer natural resources bought (water, energy, raw materials) at each stage
  - Identified and predictable costs

Other benefits include:

- *More socially acceptable processes*
  - Regulatory compliance more fully addressed (protection of assets, personnel and the environment)
- Stakeholders more involved during the lifecycle

And there is more:

- *Fewer project risks*
  - Analysis of the technical and economic feasibility of the product over its lifecycle
  - Analysis of stakeholder risks and expectations over the lifecycle
  - Introduction of new criteria to assess the project and its total cost
  - Lifecycle analysis as "impact study" of the product
- *Greater motivation within the companies*
  - A driver for launching new studies
  - A tool for innovation
  - An opportunity to enhance the status of the crafts
- *Respectability outside the company*
  - With respect to the competition
  - With respect to customers
  - With respect to administrations and standards organizations

The study highlighted the work accomplished between the last two cask generations in the fields of fresh/irradiated MOX transportation and waste transportation for a wide range of activity levels.

Eco-design approach applied to new cask design for fresh MOX fuel transportation

Our preliminary study focused on comparing two fresh MOX fuel shipping casks, developed about 7 years apart: the FS65 and the MX6.

The MX6 concept optimizes the environmental impacts for an identical quantity of fuel transported. Improvements include:

- reduction of the size, weight and number of raw materials used;
- an increase in the quantity of material transported per cask;
- the introduction of more environmentally-friendly fabrication materials and processes;
- a decrease in the quantity of toxic products used;

- simplified maintenance;
- optimization of product decommissioning at the end of the lifecycle.

Performance indicators were defined so as to compare environmental benefits for each cask, based on an equal quantity of fuel transported:

- quantity of steel used,
- quantity of resin used,
- transportation flows,
- operator unloading time,
- maintenance time.

Design and Fabrication

For the same quantity of fuel transported, the use of the MX6 cask reduced the quantity of raw materials used in cask fabrication (steel, resin, etc.) by about 50%. In addition, the new cask's improved materials performance, especially for resins, translates into better radiation protection performance. A smaller amount of resin is used. A system of adjustable baskets was developed during the design in order to standardize fabrication. Also, an innovative system is used to support the fuel during transport, eliminating the need for anchors. A continuous improvement initiative applied to machining processes optimized the quantity of forged parts. The quantity of forged part turnings was also optimized, and this operation now generates a minimum of secondary waste. The waste and resin scrap are recycled through suitable channels.

Transportation

For the same quantity of fuel transported, two shipments of two MX6 casks correspond to three shipments of twelve FS65 casks. This 33% decrease in transportation flows helps reduce greenhouse gas production.

Operations

The smooth body of the MX6 makes it easier to perform the required radiological controls. Secondary waste and the number of operations to be performed by the operator and the time spent on them are minimized.

Maintenance and Decommissioning

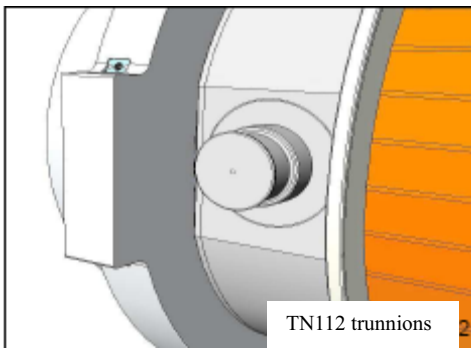
Apart from the reduction in maintenance and decommissioning operations due to the lower number and weight of the casks, the original concept and innovative servicing system of the MX6 helps reduce heavy maintenance operations, the number of hours of skilled labor required, and the volume of waste generated.

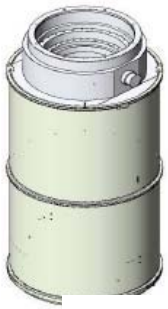
The results
The results of the MX6 eco-design can be expressed as follows: The Logistics business unit's eco-design method is a decision-making tool for environmental impact reduction and environmental performance assessment of products.
The study shows that the MX6 cask successfully incorporates all eco-design aspects.

Eco-design approach to the TN112: A new irradiated MOX and UOX fuel cask to replace the TN12

The eco-design approach came into play during the design of the TN112 cask, translating into lower exposures, less maintenance and fewer operations for increasingly challenging packages:

- exposure during unloading operations reduced by 15% compared with the TN12;
- faster turnaround time through the use of optimized tooling;
- gains in pre-transport cleanup time;
- better control over the quantity of raw materials used;
- simplified maintenance;
- more flexibility in the types of assemblies to be transported.


TN112 trunnions


TN112 Full-length skirt

Increased protection
Particular attention was paid to reducing the need for cask replacements in the future by anticipating the future physical and chemical requirements associated with MOX and UOX fuel. In relation to the TN12, the TN112 also offers better radiological protection and a stronger fissile materials isolation system (double containment).

Resin containment
The cask can be pressure-cleaned, since the resin is surrounded by copper. This improves operating procedures and gives greater latitude with regard to decontamination.

Contamination prevention
The original concept for the TN112 cask and related equipment helps minimize areas that can retain water or are difficult to decontaminate. The product's eco-design translates into reduced decontamination operations and fewer hours for the related skilled labor. Resulting waste volumes are also optimized.

Optimization of the trunnions
Part of the design studies were devoted to developing a unique, optimized system for trunnion placement. By placing them off-center in relation to the cask cavity, the TN112 gets better dose performance than the TN12 for the same level of activity, and thus has fewer environmental impacts.

Integrated skirt
The integrated skirt covering the entire length of the TN112 cask was specially designed to reduce cask cleaning time prior to transportation.

Tooling
The number of new tooling items to be developed was optimized to allow for the reuse of existing TN12 tooling to the extent possible. This translates into more rapid deployment of the TN112 while limiting the use of additional raw materials and the quantity of waste associated with them.

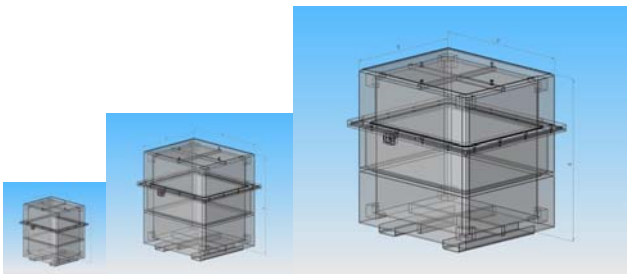
Dosimetry results
For comparable unloading operations of the TN12 and the TN112, the latter's eco-design reduced exposure by 15%.

Eco-design approach applied to a new multi-modal cask concept

In a highly competitive environment, the challenge for the development of this multi-modal cask was to combine technological expertise and environmental protection with economic viability:
make it simple and keep costs down while innovating in the use of materials and complying with regulations and the environmental requirements of the sustainable development initiative adopted by AREVA.

Design and Fabrication
A single concept was developed to meet several requirements, from the transportation of irradiators and waste subject to radiolysis, to the transportation of discontinued casks used for on-site transfers featuring a transportable content weight well above that of the cask. The new concept is being developed for highway transportation, with a transportable content weight equal to the cask weight.

Pooling the design helped reduce:
- ➔ Development
- ➔ Qualification testing
- ➔ Instruction manuals
- ➔ Purchases
- ➔ Training
- ➔ Paper



Moreover, the use of materials such as rare woods or complicated steels was avoided. The design of the FAR shell calls for the use of conventional materials such as:

- Standardized 304 L stainless steel
- Category 8-8 screw products in carbon steel
- Aluminum alloy
- Elastomer seals
- Phenolic foam

Operations

- Limited number of screws (x16)
- Guide pins for rapid closure
- Limited tightening torque
- Handling with fork lift pallet truck
- **Easier decontamination:** No retention areas, 100% of the accessible surface in stainless steel, FAR shell can be completely decontaminated without the use of decontaminable paint or changing of components.

Transportation

For the same quantity of containers transported, two shipments with one shell versus three shipments with the casks habitually used. This 33% decrease in transportation flows helps reduce the production of greenhouse gases.

Maintenance

The simplicity of the design limits maintenance to the replacement of the springs, the screws and the seals, resulting in:

- Fewer maintenance operations
- Lower waste volumes
- No chemical products for paint touch-ups during maintenance

Decommissioning

The very simple concept of the FAR shell and the possibility of decontaminating it completely minimize the volume of radiological waste generated during decommissioning.

In summary, an innovative and creative approach to meeting stakeholder expectations

The eco-design approach is used to document a response to sustainable development that applies innovation and creativity to the development of new cask concepts: being more efficient in responding to our customers by increasing operating performance while complying with regulations and reducing environmental impacts throughout the lifecycle:

- Design and Fabrication
- Transportation
- Loading, Unloading and Operation
- Maintenance, End of Life Cycle and Decommissioning

Performance improvement and new technological choices have resulted in even safer and more environmentally-friendly cask designs.

Developing know-how in research and innovation and promoting product lifecycle analysis are drivers for the eco-design approach at AREVA's Logistics business unit.

We are gradually integrating eco-design into all of our processes and projects to meet durability requirements and satisfy all stakeholders. These technology advances are anchored in a strong sustainable development and continuous improvement initiative, which is the keystone of AREVA's business strategy.