Design of a cask dedicated to deconstruction waste
1. Presentation of ROBATEL Industries

2. Transportation cask of radioactive materials
   - Definition & Functions
   - Requirements & Constraints

3. Presentation of cask R73
   - Example - Cask dedicated to Deconstruction Wastes

4. Design process
   - Positioning of Contents
   - From User to Use

5. Deconstruction: The Operator's Expectations
   - Costs, Flow and Industrial Process

6. Constraints on Design
   - Search for Optimum Design vs. Needs

7. Impact on Operations
   - Key - Operator Involvement

8. Conclusion
**French company founded in 1830**

**Devoted to Nuclear Industry for over 50 years**

> 110 Employees

**4 Offices in France** (ROBATEL Industries):
- Genas / La Hague / Marcoule / Cadarache

**1 Subsidiary in U.S.** (ROBATEL Technologies)

**Activities:**
- Studies / Manufacturing / Maintenance
- On-site operations

**Areas:**
- Hot cells
- Gloves boxes
- Various equipments for Nuclear Industry
- **Transport Casks for Radioactive Material:**
  - Design of more than 70 designs of Type B casks (Fissile or not fissile)
  - Manufacturing of over 800 casks (types A, B, industrial or site ...)

Genas headquarters
A « container » for the transportation of radioactive materials that ensures environmental and public safety

Safety functions:
- Containment of contaminated materials
- Protection from radiation
- Maintenance of subcriticality
- Guaranteed Safety regardless of carriage conditions:
  → routine, normal or accident conditions of transport.

Key secondary functions:
- Mechanical protection in case of a transport accident
- Thermal protection in case of fire during the transport
- Dissipation of thermal inner power

Notion of « package »:
- Group formed by « cask & radioactive contents »
- Guarantee of Cask Safety is based on contents
- Cask design is inseparable from its content
Cask ROBATEL R64:

Transport of neutron sources
Design of a cask dedicated to deconstruction waste

Cask ROBATEL R72:

Transportation of irradiated fuel rods
Design of a cask dedicated to deconstruction waste

Design around the content

Cask ROBATEL R73:
R73 : Presentation

- **Type of cask**: B(U)
- **Mode of transport**: Road or Rail
- **Dimensions**: $\Phi_{\text{ext}} \times H_{\text{ext}} = 2210 \times 2370 \text{ mm}$
  $\Phi_{\text{int}} \times H_{\text{int}} = 1040 \times 935 \text{ mm}$
- **Total mass in load**: 24 tons
- **Maximum mass of wastes**: 2 tons
- **Content**: Metallic wastes with average activity from the decommissioning of EDF plants
- **Packaging**: Wastes loaded in bulk in a wire basket
- **Use**: Transport of wastes from EDF sites in deconstruction to a Plant for packing and...
The design of a cask is divided into four steps:

1. **Definition of eligible content**

   *European Guide* : « Detailed descriptions of radioactive contents planned for cask design should contain, at a minimum, the following information (...):
   
   a) Radionuclide / isotopic composition
   
   b) Limitations in terms of activity, of mass and of concentrations, heterogeneities
   
   c) Physico-chemical state, geometry shape, layout, irradiation parameters, moisture content, material specifications
   
   d) (...)
   
   e) Nature and characteristics of radiation emitted
   
   f) Limitations in terms of thermal power of contents
   
   g) Mass of fissile material and radionuclides
   
   h) Other hazardous properties
   
   i) Unauthorized contents

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**Deconstruction waste:**

- Crosspieces holding
- Command Bars
- Alignment pins
- Lead shielded shell
- Extension lead
- Guide tubes
- Adapters
- Permissible content # 1
- Permissible content # 2
- Permissible content # 3
- ...
Design process

2. Design of cask:
   - Packaging of contents: Internal Facilities
   - Safety functions: Biological protection/ thermal / mechanical
   - Functional interfaces (sites operators / stowing / handling ...)

- Contents to be transported
- Size constraints
- Internal adjustments
- Containment of the activity
- Biological shielding
- Thermal protection
- Mechanical protection
- Protection against impact
- Handling equipment
- Functional interfaces
Design process

3. Safety justification and regulatory compliance:
   - Calculations and numerical simulations (radiation protection, containment, thermal, mechanical, criticality, radiolysis ...)
   - Testing and Experimentation (drop tests, punch test, thermal behavior, sealing, qualification process ...)
   - Feedback, R&D

Design of a cask dedicated to deconstruction waste
4. Approval request from Nuclear Safety Authority:
   - Exchanges and technical expertise: Designer / ASN / IRSN / GPT*
     - Cask design: iterative process
     - Involvement requested from Operator
Operator expectations

- Plan for a lot of transports:
  - Deconstruction of old EDF plants (current and future ...)
  - Over a decade, several hundred tons of waste to be transported to ICEDA (tens of transport / year)

- Optimize costs → Optimize the flows:
  - Maximize the loading capacity of the cask (weights / volumes ...)
  - Optimize the functionality and interfaces of the cask (industrial environment)
Operator expectations

- Transport a large quantities of waste: $\rightarrow 2\ 000\ \text{kg/cask}$
- Carry large activities: $\rightarrow < 2\ 000\ \text{TBq (Co}^{60})$
- Transport a variety of waste and configurations:
  - Cutting and packing plans:
    - Cuts, storage, loading bulk...
  - Origins, geometries and dimensions:
    - Various components from decommissioning
    - Plates, tubes, rods, massive parts...
    - From few g ... to several hundred kg
  - Constituent materials:
    - Steel, inoxs and other metallic materials...
    - Potential presence of non-metallic materials
  - Radiological properties:
Design constraints

- **Design integration of deconstruction needs**:
  - Loading of 2000 kg of waste:
    - Maximize the useful volume of loading
    - Mechanical design of resistance elements (lid, screws...)
  - Loading activity until 2 000 TBq Co\textsuperscript{60} equivalent:
    - Optimize biological protection
    - Account for fluctuations of the radiation characteristics
    - Account for possible heterogeneity of activity in the loading
  - No constraint on the packing waste → No chocking possible → Accounting for the possibility of internal moving of material:
    - In terms of radioprotection
    - In terms of mechanical aggression of the containment system
  - Conventional transports:
    - Limitation of traffic congestion and total rolling mass
  - Transport in the deconstruction case → industriel setting:
### Design constraints

#### Example: Defining radiological limits of Contents

- **Technical specifications:**
  - Homogeneous voluminous activity in equivalent Co\(^{60}\)

- **Work on limitations of admissible content:**
  - Definition of a mass spectrum of gamma activity

<table>
<thead>
<tr>
<th>Mass activities (Bq/kg)</th>
<th>Eligible spectrum (Limits for each energy group considered individually)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a_{m_{0.66MeV}} )</td>
<td>( a_{m_{0.66MeV}} \leq A_{m_{0.66MeV}} )</td>
</tr>
</tbody>
</table>

- **If only 1 level:** \( a_{m_{i}} \leq A_{m_{i}} \)
- **If several levels:** \( \sum a_{m_{i}} / A_{m_{i}} \leq 1 \)
Design constraints

Example: Defining radiological limits of Contents

- Impact on safety analyzes: Radioprotection
  - Account for possible heterogeneities
  - Account for potential materials shifting

*within the limits allowed by the spectral definition of the content*
Impacts on the operating

- Justification of waste conformity with limits defined for the package:
  - Required waste characterization

- Justification possible on the base for example:
  - Previous knowledge on decommissioning operations conducted (feedback), and/or :
  - Specific characterization and / or development of numerical models for evaluation (R&D), and/or :
  - Measures and additional checks for loadings (operating)

- Definition of contained envelopes formulated in a generic way:
  - Ability to envelop a broad range of wastes for transport
  - Requirement to characterize waste as related to transport limits for contents

- Waste characterization - often oriented to disposition, not transportation
  - Insufficient data for transportation
  - Further analysis may be required
Conclusion

- **Casks dedicated to deconstruction wastes:**
  - Not just basic rubbish bins:
    - casks full-fledged

- **Specific design constraints:**
  - Diversity of waste (already produced or to be produced) makes difficult:
    - Comprehensive description of content
    - The definition of limitations but enough envelopes.
      - Limitations consistent with the constraints of deconstruction site,
    - Cask design and safety justifications resulting,

- **Process requiring iterations and consultations:**
  - Operator → Designer → Safety Authorities ...
    - ... Safety Authorities → Designer → Operator

- **Transportation of deconstruction wastes:**
  - Casket development and testing
Conclusion

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Thank you for your attention