ENSA (Grupo SEPI)

Ensa Solutions for Interim Dry Spent Fuel Storage & Transportation

INMM 31\textsuperscript{st} Spent Fuel Management Seminar
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Spent Fuel Cask
Outline

• Spain
  o Actual Spent Fuel Scenario
  o Spanish Spent Fuel Strategy for the near Future
  o Ensa’s Technological Solution Approach: the ENUN casks series

• China
  o The ENUN 24P project

• Upcoming Challenges

• Conclusions
Actual Spent Fuel Scenario

Nuclear Spent Fuel Inventory: around 5,000 tU in Storage (FA)

- Most of them at NPP pools (*Wet Storage, Racks*)
- 3 ISFSI under operation (*Dry Storage, Casks*)
  - Trillo NPP
  - José Cabrera NPP
  - Ascó NPP
- 1 ISFSI under construction (*Dry Storage, Casks*)
  - Sta. Mª de Garoña NPP
- 1 ISFSI under design (*Dry Storage, Casks*)
  - Almaraz NPP (units I and II)
- 1 Centralized Storage Facility in process (*Dry Storage, Vault*)
  - ATC (Villar de Cañas)
Actual Spent Fuel Scenario

- **Under Construction ISFSI, Sta. Mª Garoña NPP**
- **Under Design ISFSI, Almaraz I&II NPPs**
- **In process Centralized Storage Facility, ATC (Villar de Cañas)**
- **Operating ISFSI, Trillo NPP**
- **Operating ISFSI, Ascó I&II NPPs**
- **Operating ISFSI, José Cabrera NPP**
Estimated total amount of nuclear spent fuel waste, after 40 years of all NPP operation:

6,700 tU (20,000 Fuel Assemblies)
Spanish Spent Fuel Strategy for the near Future

- Spent fuel will remain temporarily dry stored at the ISFSIs of the NPPs
- Later on, all casks will be transported to the ATC (Centralized Interim Storage Facility)
- Once in the ATC:
  1) Temporary storage in the ATC cask storage building;
  2) Transfer of fuel (hot cell) from the cask to the canisters;
  3) Interim storage using welded canisters (initially licensed for 60 years but designed for 100);

**ATC Technology:** Vault system for SF and HLW (Vitrified)
Spanish Spent Fuel Strategy for the near Future

Restrictions imposed by different stakeholders:

- **Spanish Government:**
  - 6th General Radioactive Waste Plan (2006) gives priority to centralized interim storage (ATC=Vault system);
  - search for a global cask solution
    - a cask concept designed for the Spanish strategy: the ATC (a bolted dual-purpose cask);
    - lower cost;
    - simplicity for transport and transfer (from cask to vault);
    - customized for each NPP requirements;

- **Trillo NPP:** current Ensa-DPT casks cannot cover actual fuel parameters. Need for an enhanced cask solution (high burnup);

- **Almaraz NPP:** need a ISFSI and a standard cask solution;

- **Sta. Mª de Garoña:** need a ISFSI and a specific cask solution;

- **Cofrentes NPP:** needs a specific cask solution;

- **All NPPs:** provide a solution for damaged fuel;
Ensa’s Technological Solution Approach

The new Dual-Purpose ENUN Cask Series
Ensa’s Technological Solution Approach

**ENUN 52B: Sta. Mª de Garoña NPP**

- Designed to cover **Sta. María de Garoña** NPP fuel parameters (initially GE-6 and GE-7);

- Light weight and reduced dimensions because of NPP limitations:
  - Weight: 70 tons;
  - Outer diameter:
    - Cask 2.2 m;
    - Transport configuration: 3.1 m

- Licensed by ENSA in Spain:
  - Storage -> 2014
  - Transport (low burnup) -> 2015

- Current book order:
  - 5 manufactured casks + ancillary equipment;
  - Expected loading campaigns: early 2017;
Ensa’s Technological Solution Approach

**ENUN 52B:** Sta. Mª de Garoña NPP

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**Cask body:**
- Monolithic carbon steel

**Basket:**
- ‘Egg-crate’ structure, stainless steel + aluminum + MMC

**Closure system:**
- 2 bolted lids

**Ancillary equipment:**
- Transfer crane, lifting yokes, draining system, etc.
Ensa’s Technological Solution Approach

**ENUN 32P: Trillo and Almaraz NPPs**

- Designed to cover all **Trillo, Almaraz, Ascó I & II** and **Vandellós II** NPPs fuel parameters (KWU 16x16 and W 17x17);

- Optimized respect to former Ensa-DPT design (90’s)
  - Lowering the cost;
  - Increasing capacity, burnup, heat load, fuel types and NFH;
  - Enhanced technology (materials, burnup credit, etc.);

- **Licensed by ENSA in Spain:**
  - Storage -> 2015
  - Transport (low burnup) -> Early 2016
  - Transport (high burnup) -> 2017

- Current book order:
  - 10 manufactured casks + ancillary equipment;
  - Expected loading campaigns: early 2018 both Trillo and Almaraz NPPs;
Ensa’s Technological Solution Approach

**ENUN 32P:** Trillo and Almaraz NPPs

- **Cask body:** monolithic carbon steel
- **Transport impact limiters:** Poliurethane foam, Aluminium honeycomb
- **Basket:** ‘Egg-crate’ structure, Stainless Steel + Aluminum + MMC

Closure system:
2 bolted lids
Ensa’s Technological Solution Approach

**ENUN 32P**: Trillo and Almaraz NPPs

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial enrichment (% wt. U-235)</td>
<td>4.90 %</td>
</tr>
<tr>
<td>Burnup (MWd/MtU)</td>
<td>65,000</td>
</tr>
<tr>
<td>Minimum cooling time (years)</td>
<td></td>
</tr>
<tr>
<td>a) Uniform loading</td>
<td>16</td>
</tr>
<tr>
<td>b) Zonal loading</td>
<td></td>
</tr>
<tr>
<td>(Region 1, periphery)</td>
<td>21</td>
</tr>
<tr>
<td>(Region 2, center)</td>
<td>9</td>
</tr>
<tr>
<td>Maximum thermal load (kW)</td>
<td>36.2</td>
</tr>
</tbody>
</table>

Uniform loading: 32 FA

Zonal loading: 20 + 12 FA

28 FA + 4 NFH

**NFH**: Control rods, BPRA, WABA, etc.
P.R. of China: The ENUN 24P Project

- **Purpose:** transport spent fuel from 2 NPPs to Lanzhou storage facility

- **PWR plants:**
  - Ling Ao
  - Daya Bay

- **Current solution:**
  - STC-26

- **User selects a new enhanced solution, the ENUN 24P:**
  - Improved design and materials;
  - Transport of high burnup fuel;
  - Reduced outer dimensions;
  - Optimized cost;
P.R. of China: The ENUN 24P Project

- Designed to cover Ling Ao and Daya Bay NPPs fuel parameters (AFA 2G, AFA 3G and AFA 3GAA);

- Technical challenge:
  - Fuel parameters: 57,000 MWd/tU; 5 years cooling;
  - No burnup credit allowed;
  - Outer package dimensions limited to 3.3 m;
  - Customized solution in tight schedule: < 3 years;

- Need to be licensed in Spain and China:
  - Transport (high burnup) -> end of 2016 (currently under regulatory body evaluation);
  - Storage -> 2017;

- Current book order:
  - 1 manufactured casks + ancillary equipment + loading support;
  - Expected loading campaigns: beginning 2017;
Upcoming Challenges

- **SAR amendment of ENUN P casks for transport of high burnup spent fuel (> 45,000 MWd/tU):**
  - Comply with requirements from NRC ISG-11, Rev. 3 and IAEA SSR-6;
  - Agree of methodologies with nuclear authorities;
  - Collaboration with US National Labs in transportation test program using an ENUN 32P full scale cask;

- **SAR and TSAR amendment of all ENUN dual-purpose casks to load damaged fuel:**
  - Design of specific can for damaged fuel: customized to each ENUN cask;
  - Compatible with ATC canisters;

- **Enhance the design of the ENUN 52B cask to load all spent fuel from Sta. Mª de Garoña NPP (Spain):**
  - Current: GE-6, GE-7; Target: GE-4; GE-5; GE-8; GE-10, GE-11; GE-14, etc.

*Continue developing components for the safe management of the nuclear spent fuel worldwide, offering enhanced and customized technical solutions,*
Conclusions

✓ In Spain, most of the SF is actually stored in pools at NPPs;
✓ Current dry storage systems do not cover all existing spent fuel conditions: enhanced cask designs and technical solutions are needed;
✓ Dry storage is required to cover the need of emptying the pools and transport the spent fuel, until the ATC is ready;
✓ High burnup fuel transport requirements need to be addressed;
✓ ENUN cask series successfully cover the needs for the Spanish spent fuel scenario;
✓ Ensa is currently doing a great effort to customize the ENUN 24P, for the safe transport of high burnup spent fuel in China;
✓ Ensa is continuously supporting and being involved on different international programs to find optimal solutions for the spent fuel management strategy;
Thanks for your attention!