NAC International Presents:
NAC’s MAGNASTOR® System:
The Next Generation of Advanced
Spent Fuel Storage for the U.S.

ISSF2010
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Interim Storage of Spent Fuel
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a Leading Supplier of Enriched Uranium Fuel for Commercial Nuclear Power Plants
NAC’s MAGNASTOR System: The Next Generation of Advanced Spent Fuel Storage for the U.S.

Topics

- NAC International Background
- Overview of the MAGNASTOR System
- Development of the MAGNASTOR System
- Advanced Features of the MAGNASTOR System
- Deployment of the MAGNASTOR System
- Questions and Discussion
NAC International Background

NAC Technology at a Large Spent Fuel Dry Storage Facility at the Connecticut Yankee Plant Outside Haddam, Connecticut
NAC Background and History

- NAC was founded in 1968
- NAC is a provider of global nuclear fuel cycle services and products:
  - Spent Fuel Management and Storage Technology
  - Spent Fuel Transportation Systems and Services
  - Worldwide Nuclear Consulting
  - U.S. Department of Energy (DOE), Government Agency Support
- NAC is Owned by the United States Enrichment Corporation, Inc. (USEC)
- NAC Headquarters located in Norcross, Georgia, USA
- Other NAC Offices - Tokyo, London, and Moscow
NAC International Overview
Proven Nuclear System and Service Solutions

Norcross
Tokyo
London
Moscow

Consulting
Recognized Authority on Nuclear Fuel Cycle
Nuclear Fuel Database Management

Transportation Services
More than 3,600 Cask Movements Over 6 Million Miles
Cask Services at Sites

Projects/Engineering
Numerous Spent Fuel Technologies Licensed
More than 300 Storage and Transport Systems Delivered

Over Forty Years of Nuclear System and Service Solutions Experience
NAC International
Dry Spent Fuel Storage Experience

NAC Dry Storage System Experience: Totals

- 422 Ordered
- 296 Delivered
- 247 Loaded
Development of the MAGNASTOR System

NAC MAGNASTOR Casks Constructed at the McGuire Nuclear Station
Background: Why U.S. Utilities Prefer Multipurpose Canister Systems (MCS)

- Concrete-based, MCS technology gives more flexibility for uncertainty about storage duration, location, transport, or disposal
- Provides storage containment, criticality control and much of the thermal function in one element (canister)
- Shielding, physical protection and some thermal functions are provided by the overpacks (casks)
- The canister becomes the “contained” waste form, not individual fuel assemblies; allows easier movement of waste, less facility support for whatever occurs in the future.
- MCS allows significantly fewer transport casks, which are relatively much more expensive than concrete storage casks
MCS Acceptance by U.S. Utilities

- U.S. utilities very strong advocates of concrete MCS
- NAC believes this support principally driven by:
  - large uncertainties about spent fuel disposition
  - extensive flexibility provided by MCS designs
  - very reasonable MCS cost for large flexibility
- Concrete MCS technology has equal safety to metal casks, meets all regulations, is proven in performance
- NAC’s MAGNASTOR System was developed to provide utilities MCS flexibility at even lower cost per assembly
Typical NAC MCS

NAC’s MPC, UMS, and MAGNASTOR MCS technologies are very similar.

Transport overpack with canister

- Stainless steel transport cask body
- Stainless steel/lead/stainless steel cask interior body
- NS4FR high-efficiency neutron shielding
- Canister lids
- Cask lid
- 32 PWR-assembly tube-and-disk fuel basket
- Licensed impact limiter: NRC-approved materials: redwood and balsa (stainless steel shell)

Vertical concrete storage overpack with canister

- Length: up to 200 inches
- Diameter: 120 inches
- Weight fully loaded: 120 tons

Transportable storage canister

- Length: up to 101 inches
- Diameter: 70.64 inches

Transport overpack

- Length: 191 inches
- Diameter without impact limiters: 99 inches
- Weight fully loaded: 120 tons

Vertical concrete storage overpack

- Length: up to 200 inches
- Diameter: 120 inches
- Weight fully loaded: 120 tons
Lessons Learned to Achieve Better Performance and Economics with MAGNASTOR

Based on NAC’s extensive experience with UMS and MPC, several important lessons learned include:

- High capacity drives system safety, performance and economics; if possible, take advantage of larger plant capabilities to handle high capacity systems
- Higher density fuel storage can reduce dose rates and onsite/offsite exposures per assembly stored
- Final mechanical assembly of key components is more efficient, with better schedules and lower risk
- Simplified operations reduce time, cost, and dose
MAGNASTOR System Development Strategy

• Higher capacity with minimal volume increase
• Simple basket and cask design for ease of fabrication
• Utilize proven UMS and MPC technology, where it makes sense
• Incorporate customers on design review team for collection and integration of lessons learned and best practices
• Work with several fabricators early to integrate and develop efficient fabrication and construction methods into design
• Use full scale prototypes and lead component assemblies to refine fabrication methods and determine real cost
MAGNASTOR Basket Fabrication Projects

- NAC partial basket fabrication project at GEH in Pittsburgh
  – completed 12/2005
- NAC basket fabrication project at HMC in Japan
  – completed 12/2006
- NAC, Ceradyne & GEH fabricated first deliverable MAGNASTOR basket applying full QA
  – completed 6/2009
- Others in process
U.S. MAGNASTOR System Summary

- Concrete storage system, with dual purpose canister
- System capacity: 87 BWR or 37 PWR assemblies
- System thermal capacity: BWR 33 kW; PWR 35.5 kW
- Loaded weight: 161 tons (146.4 Mt) on storage pad
- Basket: developed cell, mechanical final assembly
- Canister redundant closure design: single lid, seal ring
- Transfer cask operations lift: <115 tons (104.5 Mt)
- Enhanced canister draining, drying features
# MAGNASTOR System Design Parameters

<table>
<thead>
<tr>
<th>Fuel Specific Data</th>
<th>PWR / BWR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Assembly Capacity</strong></td>
<td>37 / 87</td>
</tr>
<tr>
<td><strong>Thermal Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>(Storage)</td>
<td>35.5 kW / 33 kW, maximum (40 kW Design Basis)</td>
</tr>
<tr>
<td>(Transport)</td>
<td>23KW / 22 kW, maximum (Initial License)</td>
</tr>
<tr>
<td><strong>Fuel Cool Time</strong></td>
<td></td>
</tr>
<tr>
<td>(Storage)</td>
<td>4 years, minimum</td>
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<tr>
<td>(Transport)</td>
<td>To meet maximum heat load limits</td>
</tr>
<tr>
<td><strong>Fuel Initial Enrichment</strong></td>
<td>5.0 w/o / 4.5 w/o, U\textsuperscript{235} maximum</td>
</tr>
<tr>
<td><strong>Fuel Burn-Up (Assembly Average)</strong></td>
<td>60 / 60 GWD/ MTU maximum</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Key System Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VCC Length</strong>: Standard Cask</td>
<td>225 inches</td>
</tr>
<tr>
<td>Segmented Body</td>
<td>204 / 194.5 inches (MAG-E)</td>
</tr>
<tr>
<td><strong>VCC Outer Diameter</strong></td>
<td>136 inches</td>
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<tr>
<td><strong>Canister Cavity Length</strong></td>
<td>Type 1 – 173 inches</td>
</tr>
<tr>
<td></td>
<td>Type 2 – 180 inches</td>
</tr>
<tr>
<td><strong>Internal Cavity Diameter</strong></td>
<td>71 inches</td>
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<tr>
<td><strong>Overall Canister Length</strong></td>
<td>Type 1 – 185 inches /181 inches MAG-E</td>
</tr>
<tr>
<td></td>
<td>Type 2 – 192 inches</td>
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<tr>
<td><strong>Canister Shell Thickness</strong></td>
<td>0.5 inches</td>
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<tr>
<td><strong>Maximum Weight on Crane Hook (Transfer Cask loaded)</strong></td>
<td>114.25 tons / 114.75 tons</td>
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<tr>
<td><strong>Concrete Cask Maximum Weight on Storage Pad</strong></td>
<td>160 tons / 161 tons</td>
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</tbody>
</table>
MAGNASTOR System Hardware

Vertical Concrete Cask (VCC)

Canister and Basket

Transfer Cask
MAGNASTOR Operations

1. Canister in MTC is loaded in the pool
2. Canister is welded, drained and vacuum dried
3. MTC (with loaded canister) is transferred to VCC
4. VCC /canister is transferred to the pad

This is virtually the same process in use at all U.S. plants with MCS now.
Development and Licensing Summary

- Capacity: 87 BWR, 37 PWR assemblies
- Incorporates lessons-learned from industry multi-purpose system and transport cask fleet experience
- MAGNASTOR Final Rule and CoC were effective on Feb 4, 2009
Advanced Features of the MAGNASTOR System

NAC Technology at the Largest Spent Fuel Dry Storage Facility at the Largest Nuclear Plant Site in the U.S., Palo Verde Nuclear Generating Station (PVNGS) Outside Phoenix, Arizona
Advanced Features of the MAGNASTOR System

Transportable Storage Canister
- Developed cell basket – many fewer tubes than storage cells
- High strength basket material: smaller ODs, lighter system weight
- Closure for improved shielding, less welding/examination time
- Improved draining and drying design
- Unique in-pool closure approach for very low doses

Vertical Concrete Cask
- Variable liner/concrete thickness for extraordinary shielding
- Unique vertical lift design: lift lugs or air pallets
- Layered defense-in-depth against beyond-design-basis events

Transport Cask
- New, tested impact limiter design – accident loads < 60g
- Unique, patented neutron shield, conductive heat removal system
Deployment of the MAGNASTOR System
### NAC Spent Fuel System Customers: Procurements and Systems Loaded

<table>
<thead>
<tr>
<th>Customer</th>
<th>Technology Selected</th>
<th>Purchased Systems</th>
<th>Delivered Systems</th>
<th>Loaded Systems</th>
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<tbody>
<tr>
<td>Dominion - Surry</td>
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<td>2</td>
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<td>China Nuclear EIC</td>
<td>STC</td>
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<td>Yankee Atomic - Rowe</td>
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<td>16</td>
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<td>Connecticut Yankee</td>
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<td>Maine Yankee</td>
<td>UMS</td>
<td>64</td>
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<td>APS – Palo Verde</td>
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<tr>
<td>Duke Energy - McGuire</td>
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<tr>
<td>Duke Energy - Catawba</td>
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<td>16</td>
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<tr>
<td>License to INER, ROC</td>
<td>UMS</td>
<td>25</td>
<td>[25 Canisters]</td>
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<tr>
<td>Duke Energy - McGuire</td>
<td>MAGNASTOR</td>
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<td>[8 VCCs]</td>
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<tr>
<td>Duke Energy - Catawba</td>
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<td>Zion Solutions - Zion</td>
<td>MAGNASTOR</td>
<td>65</td>
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<tr>
<td>Totals (Through 18OCT2010)</td>
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<td>422</td>
<td>296</td>
<td>249</td>
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</tbody>
</table>
QUESTIONS AND DISCUSSION

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