Consolidated Interim Storage Facility Design Concepts In the United States

Nuclear Fuels Storage and Transportation Planning Project

IAEA International Conference on the Management of Spent Fuel from Nuclear Power Reactors

Joe T. Carter
Vienna, Austria.
15-19 June, 2015
Outline

- US Commercial Fuel Inventory
  - Focus on Shutdown Reactor Inventory

- Pilot Interim Storage Facility Concepts
  - Currently licensed storage systems
  - Underground storage concepts
  - Vault storage concepts
US History of Commercial Power Reactors

130 Nuclear Power Plants Built for Commercial Power Generation

- 9 Early Prototypes
  - No fuel on site
- 1 Never Operated
- 1 Disabled
  - Fuel moved to DOE
- 1 Demonstration High Temperature Gas Reactor
- 19 Ceased Operations
  - Fuel on site
  - 3 reactors on sites with ongoing nuclear operations
  - 16 reactors on 13 sites with no other nuclear operations
- 99 Operating Reactors
- 6 New Units Under Active Construction

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Projected Inventory (Dec 2015 to Dec 2060)

Current Reactors Operate 60 Years, 5 New Builds Operate 40 Years

2015: ~76,500 MTU discharged
2025: ~98,800 MTU discharged
2050: ~139,000 MTU discharged
2060: ~139,200 MTU discharged

Dry storage at ~70 sites by 2060

Estimated dry storage systems:
2015: ~2,200 loaded
2025: ~4,300 loaded
2050: ~10,300 loaded
2060: ~11,500 loaded
Commercial Dry Storage Inventory is Diverse and Growing

Inventory as of April 7, 2015

- Majority is in Large Welded Canisters
- Current dry storage inventory is diverse
- Trend toward higher capacities

1,865 Welded Metal Canisters In Vented Concrete Overpacks
74,627 Assemblies, 84.6% of Dry

Transnuclear (37%)
Holtec (41%)
NAC (20%)

12 Welded Metal Canisters in Transport Overpacks
866 Assemblies, 1.0% of Dry

189 Bare Fuel Casks
8,758 Assemblies, 10.4% of Dry

Transnuclear TN-32
Holtec Hi-Star 100
Shutdown Reactor Sites are Increasing in Number

**Four Categories of Shutdown Reactor Fuel**

**"Stranded" Reactors**
- 248 Fuel Casks, 15 GTCC Casks, 2,813MT, 7,659 Assemblies

- Zion, 61 Casks Loaded
- Yankee Rowe, 15 Casks Loaded
- Trojan, 34 Casks Loaded
- Rancho Seco, 21 Casks Loaded
- Malvin Yankee, 60 Casks Loaded
- Big Rock Point, 7 Casks Loaded
- Haddam Neck, 40 Casks Loaded
- Humboldt Bay, 5 Casks Loaded
- La Crosse, 5 Casks Loaded

**Early Shutdown Reactors**
- 265 Fuel Casks, ~11 GTCC Casks, 3,479MT, 10,648 Assemblies

- Vermont Yankee, 60 Forecast Casks, 13 Casks Loaded
- Crystal River, 42 Forecast Casks, None Loaded
- Kewaunee, 38 Forecast Casks, 14 Casks Loaded
- San Onofre 1, 2, 3, 125 Forecast Casks, 50 Casks Loaded

**Shutdown Reactors at Operating Sites**
- 67 Fuel Casks, ~6 GTCC Casks, 647MT, 3,933 Assemblies

- Dresden 1, 14 Forecast Casks, 4 Loaded
- Indian Point 1, 5 Casks Loaded
- Millstone 1, 48 Forecast Casks, None Loaded

**Announced Early Shutdown Reactor**
- 77 Fuel Casks, ~2 GTCC Casks, 823 MT, 4,660 Assemblies

- Oyster Creek, 77 Forecast, 23 Loaded
## Shutdown Sites

### Dual Purpose Canisters

<table>
<thead>
<tr>
<th>Cask System</th>
<th>Canister Family</th>
<th>Canister</th>
<th>Transportation Cask</th>
<th>Total Canisters Generated in Reference Scenario</th>
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<tr>
<td>Fuel Solutions</td>
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<td>W74T</td>
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<td>MPC-32 (HI-STORM)</td>
<td>MPC-32 (HI-STORM)</td>
<td>HI-STAR 100</td>
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<td></td>
<td>MPC-68 (HI-STORM)</td>
<td>MPC-68 (HI-STORM)</td>
<td>HI-STAR 100</td>
<td>70 Forecast, 13 loaded, remainder canister uncertain</td>
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<td>HI-STORM TranStor</td>
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<td>MP197 or MP197HB</td>
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<td>NUHOMS 32PT-S100</td>
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<td>NUHOMS 32PTH1-L</td>
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<td></td>
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<td>NUHOMS 32PTH1-S</td>
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<tr>
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<td>MP197HB</td>
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### Shutdown Sites

#### Dual Purpose Canisters (Con’t)

<table>
<thead>
<tr>
<th>Cask System</th>
<th>Canister Family</th>
<th>Canister</th>
<th>Transportation Cask</th>
<th>Total Canisters Generated in Reference Scenario</th>
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<td><strong>NAC-MPC</strong></td>
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<td>CY-MPC, 26 Assy</td>
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<td>NAC-STC Transport Cask</td>
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<td>Universal Transport Cask</td>
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<td>Universal Transport Cask</td>
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<tr>
<td></td>
<td></td>
<td>TSC-Class 3</td>
<td>Universal Transport Cask</td>
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<td><strong>NAC-MAGNASTOR</strong></td>
<td>TSC PWR</td>
<td>TSC PWR</td>
<td>MAGNATRAN</td>
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<tr>
<td>Total Potential Casks</td>
<td>20 Canister Families</td>
<td>33 Potential Canisters</td>
<td>9 Transport Cask</td>
<td>657 Fuel Casks 34 GTCC Casks</td>
</tr>
</tbody>
</table>

**IAEA June 15-19, 2015**
Example of Canister Diversity
NAC Diameters and Lengths Illustrated

NAC UMS System at Maine Yankee
Pilot Storage Facility Concept

- **5,000 to 10,000 MT capacity with a design receipt rate of 1,500 MT/year**
  - Accept dry storage canisters (DSC) from shutdown reactors, see next slide
  - Accept Greater-Than-Class C Low Level Waste from decommissioned power reactors, and other approved contents in canisters
  - Receive fuel in dual purpose canisters (DPC) in associated transportation casks
  - Deployed in modules for storage capacity and additional functional capability

- **Fully developed facilities will include:**
  - Shielded cask-handling building for transfer of the canister from transportation casks to storage overpacks
  - Storage pads with multiple vertical and horizontal storage overpack designs
  - Infrastructure and balance of plant facilities

- **Designed to Meet:**
  - 10CFR72
  - 10CFR73
  - Associated Regulatory Guides (e.g. RG 3.60, 3.48 & 3.62)
  - Guidance from NUREG – 1567 and 1927
Canister Receipt Design Concept 1

Canister Transfer Building

- **Perform Post Transportation:**
  - Inspections,
  - Radiological Surveys,
  - Decontamination (if necessary)
  - Security Receipt Inspections

- **Transfer Canister to New Overpack and Relocate to Storage Pad**
  - Vertical Casks:
    - Upright
    - Transferred to Vertical Storage Overpack using Facility Cask
    - Vertical Storage Cask Relocated to Pad
  - Horizontal Casks:
    - Loaded onto Transporter
    - Relocated to Storage Pad using Transporter
    - Transferred to HSM using Transport Cask

- **Existing Canisters are Placed into Storage w/o Opening**
Canister Receipt Design Concept 2 & 3

- Cask Handling Building with Remote Operations
  - Higher Capital versus Concept 1
  - Additional Complexity versus Concept 1
  - Did NOT Provide Significant Dose Reduction versus Concept 1

- Commercially Available Transfer Cask Used with:
  - Mobile Cranes, no weather enclosure
  - Installed Cranes in a weather enclosure
  - Diversity of Canister Types is Challenging
  - Highest Dose of the Alternatives Evaluated
  - Method Being Considered for Early Operations
Pad Storage Using Currently Licensed Storage Overpacks

- **New Horizontal or Vertical Concrete Overpacks as required**
  - Most recent licensed overpack associated with each canister type,
  - Limit to the extent possible storage overpack configurations
  - Canisters which do not have a current commercial source for new storage casks must be identified and required license actions identified
  - Considering Re-use of the Big Rock Point Fuel Solutions overpacks, segmented for transportation

- **Metal Storage/Transportation Overpacks can be Re-used**
Pilot Conceptual Generic Layout
Two 5,000MT Storage Modules
Underground Silo Storage

- Similar to UMAX deployed at Callaway and announced for San Onofre
- Reduced Security Requirements
- Reduced Storage Area Dose
- Licensing Challenges to Accept all Canister Types in a Vertical Storage Configuration
  - Adaptors for the various canister sizes
  - Fuel Orientation in currently horizontal configuration canisters
Storage Configuration Concept 3
Vault Configurations

**Vertical Configuration**
- Similar to Ft. St. Vrain
- Passive Air Cooled
  - Decay Heat Limited
- Licensing Challenges to Accept all Canister Types in a Vertical Storage Configuration
  - Adaptors for the various canister sizes
  - Fuel Orientation in currently horizontal configuration canisters

**Horizontal Configuration**
- Licensing Challenges to Accept all Canister Types in a Horizontal Storage Configuration
  - Adaptors for the various canister sizes
- Access Not Available for Every Storage Position
- Decay Heat Removal Extremely Challenging in a Passive Cooling Mode
Vault Configuration Generic Layout With Single Cask Handling Building 2 – 5,000MT Modules