Operating the Waste Management System

Presented to:
Nuclear Waste Technical Review Board

Presented by:
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U.S. Department of Energy

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Las Vegas, Nevada
System Architecture

- Underground repository
- Surface facilities
- Nevada transportation mode
- National transportation mode
- Receipt, storage, and emplacement rates and quantities
- Operating mode
- Waste types and quantities

SNF = Spent Nuclear Fuel
HLW = High-Level Waste
72 commercial reactor sites with SNF onsite
- 104 operating reactors
- 14 shutdown reactors
≈ 64,000 MTU - Projected inventory of CSNF
≈ 2,000 MTU/year - Projected generation rate
≈ 53,000 MTU are projected to be in pool storage
≈ 11,000 MTU are projected to be in dry storage
44 at-reactor CSNF dry storage facilities in 29 states
Dry Storage Technology

First Use

1986

**Single-Purpose Casks:** Casks certified for storing uncanistered SNF at Purchaser sites.

1990*

(SP)

2000

(DP)

2000

**Canister-based Storage Systems:**

**Single-Purpose** - Canisters certified for only for storing SNF at Purchaser sites

**Dual-Purpose** - Canisters (DPC) certified for storing SNF at Purchaser sites and are also licensed for transportation.

**Transportable Storage Casks:** Dual-Purpose casks certified for storing uncanistered SNF at Purchaser sites and are also licensed for transportation.

*earlier loading of canisters in 1986 at Robinson for demonstration purposes
# Waste Acceptance - CRWMS Target Receipt Rates

The rates in this schedule are targets only and do not create any binding legal obligation on the Department of Energy.

<table>
<thead>
<tr>
<th>Year</th>
<th>Commercial SNF Target Receipt Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>400</td>
</tr>
<tr>
<td>2011</td>
<td>600</td>
</tr>
<tr>
<td>2012</td>
<td>1,200</td>
</tr>
<tr>
<td>2013</td>
<td>2,000</td>
</tr>
<tr>
<td>2014</td>
<td>3,000</td>
</tr>
</tbody>
</table>
Alignment Methodology

- Allocations earned by purchasers based on “Oldest Fuel First” (OFF) Principle
- DOE Issues Annual Capacity Report (ACR) and Acceptance Priority Ranking (APR)
- SNF earning allocation is not necessarily the SNF to be delivered
Acceptance Criteria

- All of Purchasers’ SNF (regardless of type and condition) is acceptable
- Purchasers classify SNF as “standard”, “non-standard”, or “failed”
- DOE’s obligation extends to “other than standard” SNF, but delivery may be subject to delayed acceptance
- Multi-element canisters not covered by contract
Scheduling

- Purchasers with allocations submit Delivery Commitment Schedules (DCS) identifying location and range of spent fuel 63 months before delivery
- Purchasers may exchange delivery allocations up to six-months prior to delivery, subject to DOE approval
- DOE has approved DCS’s for approximately 2850 MTU
- Depending on litigation outcome, approved DCS’s could form the basis of 2010 operations
The final environmental impact statement (FEIS) studied two transportation scenarios:

**MOSTLY RAIL SCENARIO**

<table>
<thead>
<tr>
<th>Proposed Action</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(24 years)</td>
<td>&lt;1,100</td>
<td>&lt;10,000 casks</td>
</tr>
<tr>
<td>Annual</td>
<td>≈45/yr</td>
<td>≈400 casks/yr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;135 trains/yr*</td>
</tr>
</tbody>
</table>

**Estimated Cask Fleet**

<table>
<thead>
<tr>
<th>Proposed Action</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≈10</td>
<td>≈90</td>
</tr>
</tbody>
</table>

**MOSTLY TRUCK SCENARIO**

<table>
<thead>
<tr>
<th>Proposed Action</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(24 years)</td>
<td>&lt;53,000</td>
<td>≈300 casks</td>
</tr>
<tr>
<td>Annual</td>
<td>≈2,200/yr</td>
<td>≈100 trains</td>
</tr>
<tr>
<td></td>
<td>12-13 casks/yr.</td>
<td>&lt;5 trains/yr.</td>
</tr>
</tbody>
</table>

**Estimated Cask Fleet**

<table>
<thead>
<tr>
<th>Proposed Action</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≈110</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Based on three rail casks per train shipment.

FEIS states preference for rail, both nationally and in Nevada.
### RAIL SPENT FUEL TRANSPORTATION CASKS

<table>
<thead>
<tr>
<th>Model (Type)</th>
<th>Vendor</th>
<th>Capacity (MTU)</th>
<th>No. Built</th>
<th>Part 71 COC (Expires)</th>
<th>ALLOWABLE CONTENTS</th>
</tr>
</thead>
</table>
| MP-187 (Canister) | Transnuclear | 24P (10.56) | 1         | 9255 Rev 6 (9/03)     | PWR: B&W 15x15 assemblies, <3.43 w/o U-235  
5 to 8 years cooled, 30 GWD/MTU  
9 to 17 years cooled, 40 GWD/MTU  
PWR: WE 14x14 SSSt clad assemblies, <4.05 w/o U-235  
38 years cooled, 45 GWD/MTU |
| HI-STAR 100 (DP Canister) | HOLTEC International | 24P/68B (10.56/12.53) | 7         | 9261 Rev 1 (3/04)     | Allowable contents are specified in a 26-page appendix to the CoC. Every type of standard fuel assembly can be transported.  
PWR: 7 to 10 years cooled, 24.5 GWD/MTU  
15 years cooled, up to 44.1 GWD/MTU  
BWR: 8 years cooled, 24.5 GWD/MTU  
15 years cooled, 39.1 GWD/MTU |
| TN-68 (DP Bare fuel) | Transnuclear | 68B (12.53) | 15        | 9293 Rev 1 (2/06)     | BWR: 10 years cooled, 40 GWD/MTU, <3.7 w/o U-235  
(29 more are on order for storage at Peach Bottom) |
| NAC-STC (DP Bare fuel) & (DP Canister) | NAC International | 26P (11.43) | 6         | 9235 Rev 4 (3/04)     | PWR: 6.5 years cooled, 40 GWD/MTU, <3.7 w/o U-235  
10 years cooled, 45 GWD/MTU, <3.7 w/o U-235  
Max fuel assy length = 165”  
Yankee Rowe fuel: All types |
| TS-125 (DP Canister) | BNFL Fuel Solutions | 21P/64B (10.56/11.24) | 0         | 9276 Rev 0 (9/07)     | PWR: 6 years cooled, 35 GWD/MTU, <4.6 – 5.0 w/o U-235  
25 years cooled, 60 GWD/MTU, <4.6 – 5.0 w/o U-235  
BWR: Limited to all types of Big Rock Point fuel. |
| MP-197 (Canister) | Transnuclear | 61B (11.24) | 0         | 9302 Rev 0 (7/07)     | BWR: 6 years cooled, 27 GWD/MTU, <4.4 w/o U-235  
15 years cooled, 40 GWD/MTU, <4.4 w/o U-235 |
| NAC-UMS (DP Canister) | NAC International | 24P/57B (11.43/10.50) | 0         | 9270 Rev X (N/A)      | Not certified. Currently being reviewed by NRC. |

1. Average kgU per assembly based on discharges from standard reactors as given in 1994 RW-859: BWR = 184.3  
PWR = 439.8.
## Transportation Casks - Truck

### TRUCK SPENT FUEL TRANSPORTATION CASKS

<table>
<thead>
<tr>
<th>Model</th>
<th>Vendor</th>
<th>Capacity (MTU)(^1)</th>
<th>Number Built</th>
<th>Part 71 COC (Expires)</th>
<th>ALLOWABLE CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAC-LWT</td>
<td>NAC International</td>
<td>1P/2B (.44/.37)</td>
<td>8</td>
<td>9225 Rev 31 (2/05)</td>
<td>PWR: 2 years cooled, 35 GWD/MTU, &lt;3.5 – 3.7 w/o U-235 BWR: 2 years cooled, 30 GWD/MTU, &lt;4.0 w/o U-235</td>
</tr>
<tr>
<td>GA-4</td>
<td>General Atomics</td>
<td>4P (1.76)</td>
<td>0</td>
<td>9226 Rev 1 (10/03)</td>
<td>PWR: 10 years cooled, 35 GWD/MTU, &gt;3.0 &lt;3.15 w/o U-235 15 years cooled, 45 GWD/MTU, no min &lt;3.15 w/o U-235 Maximum decay heat per assembly: 0.617 kw (The GA-4 has been analyzed for partial loadings with higher decay heats. NRC approval has not been requested, but could be obtained.)</td>
</tr>
<tr>
<td>GA-9</td>
<td>General Atomics</td>
<td>9B (1.66)</td>
<td>0</td>
<td>9221 Rev X (N/A)</td>
<td>Not certified. NRC review is inactive.</td>
</tr>
</tbody>
</table>

1. Average kgU per assembly based on discharges from standard reactors as given in 1994 RW-859: BWR = 184.3  PWR = 439.8.
Of the SNF projected to be in pool storage in 2010, approximately 67% of BWR fuel and 55% of PWR fuel could be accommodated in existing cask designs.
• DOE will use existing, certified casks to the extent practicable

• Existing casks may need to be enhanced to transport higher burn-up and higher enriched SNF

• Recent industry emphasis on large rail casks

• For a mostly truck scenario, additional technology development is required
Regulations require demonstrations that casks meet performance requirements following accident tests

- Demonstrations may be done by analysis or tests

The regulatory accident tests cover over 99% of all accident conditions

- NRC has analyzed the small fraction of extra regulatory accidents
- NRC will perform tests to verify these analyses
- OCRWM has requested funds to support these tests
CRWMS Requirements Document

- Private industry will be used to the fullest extent practicable for transport
- Design and operations planning will be compatible with transportation of SNF and HLW to the repository by rail, heavy haul vehicle, and legal weight truck
- Transport standard, failed, and nonstandard commercial SNF
- Transport in NRC-certified transportation casks, including:
  + Single-Purpose Casks
  + Canister Casks - MPC and DPC (not covered by contract)
  + Transportable Storage Casks (TSCs)
  + HLW Casks
  + Specialty Casks
Transportation of Single-Purpose Storage Casks

- Single-purpose storage casks will have to be opened and repackaged at the Purchaser site
  - Dry Transfer System Topical Safety Analysis Report (TSAR) submitted to NRC in 1996
  - NRC issued Assessment Report in 12/02
  - Transmittal of TSAR Revision 1 delivered to NRC on 1/23/03

- Some Purchasers may seek one-time transportation certification for their single purpose casks (storage)
Multi-Purpose Canisters (MPC) - Current Status

- OCRWM no longer directly funds development of MPC designs, but continues to support the concept

- OCWRM plans to:
  - consider the implementation of NRC-approved disposable canisters for the OCRWM program
  - share any attendant cost savings
  - provide data on performance-based disposal criteria related to the monitored geologic repository, including preliminary Waste Acceptance Criteria for commercial spent nuclear fuel in disposable multi-element canisters

- MPCs are planned for Naval SNF
To date, no rail or highway routes have been selected

- Preliminary routes will be determined in accordance with current DOE practice for rail and DOT regulations for highway approximately 3-5 years before shipments begin

- OCRWM is committed to working with states and tribes and will consult with them in the selection of final routes
**Route Selection**

- **Highway routing (DOT 49CFR397.101)**
  - Carriers select routes to reduce time in transit
  - Vehicles transporting radioactive materials operate over preferred routes:
    - interstate highway system, including bypasses or beltways, are preferred routes
    - a state, tribe, or political subdivision may designate alternate routes consistent with DOT regulations in addition to or in lieu of the interstate highway system

- **Rail routing**
  - No Federal rail routing regulations exist
  - Current DOE practices:
    - minimize time, distance, number of carriers, and interchange points
    - maximize use of best track
    - use computer codes for route selection
Surface Facility

- Thermal management plans are finalized prior to each shipment
  - may include blending (mixing of hotter and cooler fuel assemblies)
  - may include surface storage to age SNF

- Casks are received, surveyed, spotted and unloaded

- Packaging
  - Disposal
    - bare fuel is loaded directly into waste package (blending may occur)
    - fuel in non-disposable canisters fuel is removed from canisters and loaded into waste package (blending may occur)
    - Navy MPC loaded directly into waste package
  - Storage
    - bare fuel most likely placed into storage casks (except if already in dual-purpose cask)
    - canistered fuel left in canisters and placed in concrete overpack for storage (except if already in dual-purpose cask)
Surface Facilities Layout
Potential Underground Layout

- Modular panel layout
  - Panels 1-4 sufficient for 70,000 MTHM at up to 2 meter Waste Package spacing
  - Contingency of approximately 25% with addition of Panel 5
  - Improved ventilation scheme
  - Adds optional 3rd access ramp
  - Modular development allows “adaptive staging” to applying lessons learned in one phase to the next

- Utilizes ESF for construction of small initial emplacement Panel by 2010
  - Use a portion of Panel 1 to acquire additional scientific and engineering testing

- Construction schedule to first emplacement in Panel 1: approximately 27 months
Emplacement Drift Transfer Dock

- WP Transporter
- Transfer Dock
- Waste Package
- Emplacement Gantry
Cutaway of a drift with three types of waste packages

Steel Sets for Ground Control
Gantry Crane Rail
Pressurized Water Reactor Waste Package

Boiling Water Reactor Waste Package
Codisposal Waste Package Containing Five High-Level Waste Canisters with One DOE Spent Nuclear Fuel Assembly

Drip Shield

Drawing Not to Scale
00022D-C-SCCR-V1S30-02c.ai
Much work needs to be done to achieve a fully functioning Waste Management System by 2010

Waste acceptance planning is difficult because of Purchasers’ control of SNF selection

Industry has developed and certified Storage and Transport technologies and is continuing to enhance capabilities

DOE will use private industry to the extent practicable

DOE will use existing, certified casks to the extent practicable and will support development of additional capabilities needed

“Mostly Rail” is DOE’s preferred mode

Routes will be selected 3-5 years before shipments

Surface facility operations may include blending and surface storage for thermal management purposes