U. S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
ENGINEERED BARRIER SYSTEM, TRANSPORTATION AND SYSTEMS
JOINT PANEL MEETING

SUBJECT: MULTI-PURPOSE CANISTER SYSTEM DEVELOPMENT AND PLANNING

PRESENTER: RONALD A. MILNER

PRESENTER'S TITLE AND ORGANIZATION: Associate Director, Office of Storage and Transportation.

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Dallas, Texas
November 1-2, 1993
System Operational Concept with Multi-Purpose Canisters

- Reactor Site (Spent Fuel)
- Storage Sites for Commercial/Defense High-Level Waste
- Rail Transport
- Repository
- MRS Facility

- Truck Transport (Spent Fuel)
- Rail Transport Using MPCs
- At-Reactor Storage Using MPCs
- Storage Using MPCs
- Disposal Using MPCs
Multi-Purpose Canister (MPC) System

STORAGE

Impact Limiter
MPC
Transportation Cask

TRANSPORTATION

MPC + SNF = Waste Form

DISPOSAL

MPC
Disposal Container
Waste Package

Other Possible Overpacks
MPC Conceptual Design Basis

- Meet the requirements of:
  10 CFR 71 Packaging and Transportation of Radioactive Material
  10 CFR 72 Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste

- Be compatible with the requirements of:
  10 CFR 60 Disposal of High-Level Radioactive Waste in Geologic Repositories

- Incorporate utility requirements
- Openly review MPC concept with all stakeholders
Waste Acceptance Requirements for MPC Conceptual Design

- **Initial requirements**
  - Maximize amount of SNF per canister

- **Constraint**
  - SNF has different physical, nuclear, and thermal characteristics

- **Design basis SNF characteristics:**
  
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>PWR</th>
<th>BWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum length (in)</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Maximum width (in)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Maximum weight (lbs)</td>
<td>1720</td>
<td>730</td>
</tr>
<tr>
<td>Burnup (MWd/MTU)</td>
<td>40,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Enrichment (wt% U-235)</td>
<td>3.75</td>
<td>3.75</td>
</tr>
<tr>
<td>Decay (yrs)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Decay Heat (kW/assembly)</td>
<td>0.675</td>
<td>0.317</td>
</tr>
</tbody>
</table>
Utility Requirements for MPC Conceptual Design

- Initial requirements
  - Maximize number of utilities
  - Suitable for on-site dry storage

- Constraints
  - Transportation mode
    - Rail compatible: 102 facilities
    - Truck compatible: 19 facilities
  - Handling capability if rail compatible (cask weight)
    - >125 tons: 56 facilities
    - 100-125 tons: 32 facilities
    - 75-100 tons: 14 facilities

- ALARA

- Design basis
  - 125 ton cask: 88 facilities (32 with MPC transfer cask)
  - 75 ton cask: 14 facilities
  - Truck cask: 19 facilities
  - Welded closure
  - 9 foot diameter
  - Utility Transfer System
Transportation Requirements for MPC Conceptual Design

• Initial requirements
  — Maximize use of rail facilities
  — Minimize number of shipments
  — 10 CFR 71
    « Dose rate: surface <200 mrem/hr, at 2 meters <10 mrem/hr

• Constraints
  — Operate rail cars in unrestricted interchange (maximum width 128 in., maximum car weight 394,500 lbs.)
  — Cask exterior surface temperature: <82°C
  — Criticality control: $k_{\text{eff}} < 0.95$
  — Peak cladding temperature: 10-year-old SNF <340°C, 5-year-old SNF <380°C
  — Transportation overpack compatible with MPC

• Design basis
  — 125 ton maximum
  — Transportation accident requirements
    « Burnup credit for criticality control
    « Flooded conditions for criticality control
    « No containment credit for MPC shell
Interim Storage Requirements for MPC Conceptual Design

- **Initial requirements**
  - Service life of 100 years
  - Transportable after long-term storage
  - 10 CFR 72

- **Constraints**
  - Criticality control: \( k_{\text{eff}} < 0.95 \)
  - Peak cladding temperatures: 10-year-old SNF <340°C, 5-year-old SNF <380°C
  - Storage overpack/interim storage facility at utilities compatible with MPC

- **Design basis**
  - Containment credit for MPC
  - No internal inspection prior to transportation after storage
Disposal Requirements for MPC Conceptual Design

- **Initial requirements**
  - MPC compatible with baseline thermal loading approach
    - Waste package exterior temperature: >100°C
    - Near field temperature: >100°C
    - Areal loading: 30 - 114 kW per acre
  - MPC compatible with requirements of 10 CFR 60
    - Criticality control: subcritical by five percent margin in $k_{\text{eff}}$, after uncertainties

- **Constraints**
  - Peak cladding temperature: <350°C

- **Design basis**
  - Overpack is primary engineered barrier
  - Credit will be taken for all elements, as appropriate, including fuel cladding, MPC shell
  - Burnup credit for criticality control
## Key Trades

<table>
<thead>
<tr>
<th>Issue</th>
<th>Alternatives</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MPC closure mechanism</td>
<td>Welded, Bolted</td>
<td>Minimize storage monitoring; crevice corrosion concern</td>
</tr>
<tr>
<td><strong>Economics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MPC shell material</td>
<td>Stainless Steel, Carbon Steel, Alloy 825</td>
<td>Cost; transportability after long-term storage</td>
</tr>
<tr>
<td>• Large MPC capacity</td>
<td>24 PWR vs. 21 PWR</td>
<td>Thermal constraint on cladding in repository (under review)</td>
</tr>
<tr>
<td><strong>Criticality and Thermal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Filler material</td>
<td>Yes, No, Maybe, Loading, Emplacement</td>
<td>Firm requirement not established</td>
</tr>
<tr>
<td>• Burnup credit for large PWR MPC</td>
<td>21 PWR capacity with, 17 PWR capacity without</td>
<td>Cost, shipment reduction</td>
</tr>
<tr>
<td>• Basket neutron absorber lifetime, physical integrity</td>
<td>Borated aluminum, Borated stainless steel</td>
<td>Heat transfer; lifetime at least equal to canister (under review)</td>
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</table>
RD&D Strategy for Unresolved Issues

- Criticality Control
  - Topical report working group being formed
  - Will brief NRC on long-term criticality evaluation needs 11/30/93
  - Topical report presentation planned early '95

- Thermal Loading
  - MGDS thermal loading study FY 93-94
  - Follow-on system studies FY 94-01
  - Large heater block tests FY 94-95
  - Abbreviated heater tests FY 96-99
  - ESF heater tests FY 96-01
  - Anticipated decision time frame FY 97-99

- Burnup Credit
  - Management meeting 8/27/93
  - First technical exchange 11/30-12/1/93
  - Three topical reports planned
    - For storage and transport PWR SNF - submitted 9/94
    - For disposal PWR/BWR SNF - submitted 9/95
    - For storage and transport BWR SNF - if needed
  - One year NRC turnaround requested
## Conceptual Designs for MPC

<table>
<thead>
<tr>
<th>Size</th>
<th>Capacity</th>
<th>Reactors Served</th>
<th>Number of Assemblies</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 Ton MPC</td>
<td>21 PWR</td>
<td>64</td>
<td>109,000</td>
</tr>
<tr>
<td></td>
<td>40 BWR</td>
<td>24</td>
<td>112,000</td>
</tr>
<tr>
<td>75 Ton MPC</td>
<td>12 PWR</td>
<td>5</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td>24 BWR</td>
<td>9</td>
<td>33,000</td>
</tr>
</tbody>
</table>

- Remainder of projected 298,000 SNF assemblies would be picked up from reactors in truck casks.
75 - Ton 12 PWR Configuration

- MPC Lifting Lug
- Drain Pipe
- .875 MPC Shell
- 45° Typ
- 49.62"
- 47.87"
Contingencies

- **MPC Not Emplaceable**
  - **Cause:**
    - Incompatible with repository requirements, including criticality control and thermal loading
  - **Impact:**
    - Additional cost to open, then rework, redesign and dispose, or convert to dual purpose MPC system
    - Dual purpose MPC is upper bound of impact, could add up to $500 million to program cost

- **MPC Not Transportable After Long-Term Storage**
  - **Cause:**
    - Uncertainty over condition of basket and contents
  - **Impact:**
    - Additional cost to open, then rework or design and dispose
    - Could add up to $500 million to program cost

- **No MRS**
  - **Cause:**
    - Failure to obtain MRS site consistent with system requirements
  - **Impact:**
    - Increased at-reactor dry storage, increased system costs
    - MPC mitigates impact
MPC Conceptual Design Report Products

- Volume I Summary Report
- Volume II Conceptual Designs
  - MPC
  - Transportation Cask
  - MRS
  - Utility Transfer System
- Volume III Draft RFP and Design Specifications (Procurement Sensitive)
- Volume IV Cost and Schedule
- Volume V Supporting Studies (Concept of Operations, Repository and Regulatory Considerations, others)
- Other related products (Life Cycle Cost, Risks and Contingencies, Health and Safety, Alternative Cask/Canister Concepts)
Factors for Decision to Proceed with MPC

- Should DOE incorporate an MPC system into the baseline and commence design?

- Primary criteria - evaluated for nominal case and contingencies
  - Health and safety
  - Life cycle cost
  - Licensing and regulatory compliance
  - Stakeholder acceptance
  - Waste acceptance schedule
  - Standard contract impacts
  - Flexibility in overall waste system

- Inputs to decision process
  - Conceptual Design Report
  - IMRG review
  - EEI review
  - Stakeholder workshop
  - Environmental input
  - NRC
  - NWTRB
MPC System Schedule

- MPC Schedule
  - Decision on proceeding with MPC change to technical cost/schedule baseline - January '94
  - Issue RFPs for MPC design contracts - April '94
  - Award MPC design contracts - December '94
  - MPC Safety Analysis Report Design completed for License Application submission to NRC - December '95
  - Complete final Environmental Assessment for MPCs - December '95
  - MPC system prototype testing complete - March '97
  - NRC issue Certificate of Compliance for MPCs under 10CFR71 and 10CFR72 - June '97
  - Issue RFPs for MPC fabrication - September '96
  - Award MPC fabrication contracts - June '97
  - Start MPC deployment - January '98
  - Waste Package License Application Design activities - start June '96; completed 2001
MPC Conceptual Design Conclusions

- Report asserts MPC approach offers advantages
  - Initial investment that should reduce national cost
  - Provides flexibility in interim storage system
  - Facilitates system standardization
  - Reduces bare SNF handlings
- MPC contingencies need to be addressed through
  - Analysis
  - Research
  - Design
- Decision making approach must encompass
  - Regulatory
  - Programmatic
  - Technical
  - Stakeholder