Multi-Purpose Canister Study

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Multi-Purpose Canister Study

- Background
- Multi-Purpose Canister Study
- Issues and Future Activities
Background -- Historical Background

- DOE Program Research and Development Announcement study 1985
- NRC’s concern with "compatibility of various steps in the storage, transport and disposal" of Spent Nuclear Fuel (SNF) (November, 1988)
- MRS Review Commission asked what DOE was doing to enhance compatibility
- NWTRB has expressed interest in "minimizing waste handling"
- MRS potential host concerns
- Industry
  - Edison Electric Institute
  - Electric Power Research Institute
  - Utilities
- Recent DOE analyses
Background -- Background for DOE Study

• Initiated by Director of OCRWM October 1992

• Objective
  – Evaluate benefits
  – Identify pros and cons
  – How to implement MPC’s if beneficial to program
  – Identify issues and future actions
MPC Study -- Definition of MPC

- Also called Universal Canister, Multiple Element Sealed Canister (MESC’s), and Multi-Purpose Units (MPU)
- Sealed canisters holding multiple fuel assemblies
- Canister placed in separate over-packs for storage, transportation and geological disposal
- Intention of never opening canisters once sealed
- Canister and over-pack must meet NRC Regulations
  - Reactor loading 10 CFR Part 50
  - Storage 10 CFR Part 72
  - Transportation 10 CFR Part 71
  - Disposal 10 CFR Part 60
MPC Study -- Major MPC Characteristics

- Provides structural integrity and neutron absorption to ensure sub-criticality during handling and transportation accident events
- Provides design features to maintain fuel clad temperatures below allowed maximum
- Eliminates need to handle bare SNF after receipt from reactor
- Provides compatibility with storage, transport, and disposal over-packs
- Minimizes spent fuel handling
- Meets thermal requirements for storage, transportation, and disposal
- Containment for transport and storage
- No performance allocation assigned to disposal container
MPC Study -- MPC Preliminary Design Concepts

- Large Canister
  - 21 PWR/40 BWR
  - 125 Ton canister and rail transportation cask
  - Closure: double seal weld
  - Burn-up credit and poisoned canister
  - Stainless steel

- Small Canister
  - 2 PWR/4 BWR
  - 25 Ton Legal Weight Truck cask

- Thick-walled Canister
  - 16 PWR/37 BWR
  - Ductile cast iron over pack for shielding and disposal
Small MPC - Preliminary Concept

SECTION 'A-A'
ARRANGEMENT OF 2 PWR
SNF ASSEMBLIES IN
MULTIPURPOSE LVT
(LEGAL WEIGHT TRUCK)
CANISTERS

ELEVATION VIEW
SNF ASSEMBLIES IN
MULTIPURPOSE LVT CANISTERS
Large MPU - Preliminary Concept

SECTION VIEW 'A-A'

ARRANGEMENT OF 16 PWR SIF ASSEMBLIES IN MULTI-PURPOSE UNIT

ELEVATION VIEW
MPC Study -- Evaluation Scenarios

• MPC concepts compared to Reference waste system
  – Bare Spent Fuel loaded in transportation casks at reactors
  – Bare Spent Fuel unloaded at MRS and placed in concrete storage casks
  – Bare Spent Fuel transferred from concrete storage casks to transportation casks
  – Bare Spent Fuel unloaded from transportation casks at the repository and placed in disposal containers

• MPC scenarios included various combinations of large and small MPCs
  
  Scenario 1  Large MPCs with some SNF handling at MRS
  Scenario 2  Large MPCs all loaded at reactors
  Scenario 3  Large and small MPCs loaded at reactors
  Scenario 4  Small MPCs only (cold repository)
  Scenario 5  Thick walled canister with ductile cast iron over-pack
Reference System
(Uncanistered
Spent Fuel)

Large Cask
Reactor Site

Uncanistered Spent Fuel
to MRS in Rail Casks

Small Cask
Reactor Site

Uncanistered Spent Fuel
to MRS in LWT Casks

Storage in Dry Vertical
Concrete Casks

MRS

Uncanistered Spent Fuel
to MGDS in Rail Casks

Fuel Assembly
Handling Cell

Receiving and
Handling Building

Fuel Assembly
Handling Cell

Fuel Assembly
Handling Cell

Fuel Assembly
Handling Cell

Waste Package
Preparation Building

MGDS

To
Underground

(12/21/92)
Scenario 1
(Large MPCs Only, Loaded at Reactors and MRS)

Uncanistered Spent Fuel to MRS to MRS in LWT Casks

Large MPCs to MRS in Rail Casks

Large MPCs in Horizontal Storage Modules

Receiving and Handling Building
Fuel Assembly and MPC Handling Cell

Large MPCs to MGDS in Rail Casks

Waste Package Preparation Building
MPC Handling Cell

MGDS

To Underground

(12/21/92)
Scenario 2
(Large MPCs Only, All Loaded at Reactors)

Large MPCs to MRS in Rail Casks

Large MPCs in Horizontal Storage Modules

Receiving and Handling Building

MPC Recovery Cell

Large MPCs to MGDS in Rail Casks

Waste Package Preparation Building

MPC Handling Cell

To Underground

(12/21/92)
Scenario 3
(Large and Small MPCs, All Loaded at Reactors)

Large MPCs to MRS in Rail Casks

Small MPCs to MRS in LWT Casks

Large MPCs and Small MCPs in Four-Canister Baskets, in Horizontal Storage Modules

MRS

Receiving and Handling Building

MPC Handling Cell

Small MPCs Placed in Four-Canister Baskets

Large MPCs and Small MPCs in Four-Canister Baskets to MGDS in Rail Casks

MGDS

(12/21/92)

To Underground
Scenario 4
(Small MPCs Only, All Loaded at Reactors)

Large Cask Reactor Site

Small MPCs to MRS in LWT Casks

Small MPCs in Four-Canister Baskets in Horizontal Storage Modules

MRS

Receiving and Handling Building

MPC Handling Cell *

* Small MPCs Placed in Four-Canister Baskets

Small MPCs to MRS in LWT Casks

Small MPCs in Four-Canister Baskets

Rail

Small MPCs in Four-Canister Baskets to MDGS in Rail Casks

MPC Handling Cell

Waste Package Preparation Building

MPC Handling Cell

MGDS

To Underground

(12/21/92)
Scenario 5
(Large and Small MPUs, All Loaded at Reactors)

Large MPUs (MPCs in Multi-Purpose Overpacks) to MRS by Rail

Small MPUs (MPCs in Multi-Purpose Overpacks) to MRS by LWT

MRS

Large MPU Storage

Small MPU Storage

MGDS

To Underground

Large and Small MPUs to MGDS by Rail

Waste Package Preparation Building

MPC Handling Cell

(12/21/92)
MPC Study -- Evaluation Criteria

- Quantitative
  - SNF Handlings
  - Occupational and Public Radiation Exposure
  - Schedule impacts
  - Cost

- Qualitative
  - Public Perception
  - Licensing
  - Contract Resolution
  - Flexibility
## MPC Study -- SNF Handlings

<table>
<thead>
<tr>
<th>SNF Handlings (thousands)</th>
<th>Ref.</th>
<th>Large MPC &amp; BSNF</th>
<th>All Large MPC</th>
<th>Large/Small MPC</th>
<th>All Small MPC</th>
<th>Large/Small MPU</th>
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<tr>
<td>Bare Assemblies</td>
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<td>326</td>
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<td>Heavy Containers</td>
<td>160</td>
<td>125</td>
<td>108</td>
<td>166</td>
<td>1059</td>
<td>179</td>
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## MPC Study --
Occupational and Public Radiation Exposure

### Scenarios

<table>
<thead>
<tr>
<th>Person-Rem (thousands)</th>
<th>Ref.</th>
<th>Large MPC &amp; BSNF</th>
<th>All Large MPC</th>
<th>Large/Small MPC</th>
<th>All Small MPC</th>
<th>Large/Small MPU</th>
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<tr>
<td>At-Reactor</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>17</td>
<td>102</td>
<td>18</td>
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<tr>
<td>CRWMS</td>
<td>17</td>
<td>17</td>
<td>13</td>
<td>22</td>
<td>143</td>
<td>40</td>
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<tr>
<td>Total</td>
<td>25</td>
<td>28</td>
<td>24</td>
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- Public portion of above total: 3 1 5 50 9
## MPC Study -- Comparative System Costs

<table>
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<th>Element ($M 1992)</th>
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<th>1</th>
<th>2</th>
<th>3</th>
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<td></td>
<td>2190</td>
<td>1240</td>
<td>1210</td>
<td>1280</td>
<td>2990</td>
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<td><strong>Waste Fund</strong></td>
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<td><strong>Addl. Equipment</strong></td>
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<td>53</td>
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<td>56</td>
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<td>56</td>
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<td><strong>Transportation</strong></td>
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<tr>
<td>- Casks/Overpacks</td>
<td>1044</td>
<td>707</td>
<td>610</td>
<td>724</td>
<td>1670</td>
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<td>- Operations</td>
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<td>3080</td>
<td>2380</td>
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<td>15000</td>
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<td><strong>MRS</strong></td>
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<td>- Facilities</td>
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<td>650</td>
<td>626</td>
<td>774</td>
<td>1430</td>
<td>124</td>
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<td>- Operations</td>
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<td>1100</td>
<td>896</td>
<td>1070</td>
<td>1910</td>
<td>804</td>
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<td><strong>MGDS</strong></td>
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<td></td>
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<tr>
<td>- Waste Package</td>
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<td>5190</td>
<td>5190</td>
<td>5920</td>
<td>14300</td>
<td>10300</td>
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<td>- Trans MESC D&amp;D</td>
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<td>- Surf./Subsurf. (NE)</td>
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<td><strong>Total Waste Fund</strong></td>
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<td>22694</td>
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<tr>
<td><strong>System Costs</strong></td>
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<td>19220</td>
<td>18262</td>
<td>20484</td>
<td>44733</td>
<td>23173</td>
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</table>
MPC Study -- Comparative System Cost Breakdown

$ Thousands of Millions

- Aggregate Total
- MGDS
- MRS
- Transportation
- Utilities

Ref 1 2 3 4 5
MPC Study -- Summary of Economic Results

- Compared to Reference design, large MPC’s show potential for $1 Billion savings (Scenario-2).

- Compared to large MPC’s, small MPC’s cost twice as much, increase transportation costs by 6 times and more than double utility costs (Scenario-4).

- All scenarios except small MPC’s (Scenario-4) significantly reduce utility total costs.

- All scenarios increase waste package costs compared to Reference design.
## MPC Study -- MPC Implementation Schedule

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHASE I - DETAILED EVALUATION</strong></td>
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</tr>
<tr>
<td><strong>PHASE II - DESIGN &amp; LICENSING</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PHASE III - S&amp;T DEPLOYMENT</strong></td>
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<tr>
<td>For At-Reactor Storage (Utility)</td>
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<tr>
<td>For MRS Facility (DOE)</td>
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<tr>
<td><strong>PHASE IV - REPOSITORY DEPLOYMENT</strong></td>
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<tr>
<td>Repository Activities</td>
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</tr>
<tr>
<td>Cask-to-Cask Transfer Device</td>
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<tr>
<td>2nd Generation MPCs</td>
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</tbody>
</table>
MPC Study -- Preliminary Technical Conclusions

- Maximum benefits achieved with all sites using large MPC’s
  - 100% clean MRS
  - Standardization on site storage

- Large MPC’s not compatible with low-thermal loading repository

- MPC upper bound capacity about 21 PWR assemblies

- Presently licensed MESC’s and those under design by vendors are not believed to be certifiable for disposal under 10 CFR Part 60 regulations

- Burn-up credit must be incorporated in the MPC design
MPC Study -- Advantages

- Facilitates compatibility of at-reactor dry storage with CRWMS
- Allows shutdown reactors to proceed with expeditious decommissioning of spent fuel pools
- Allows direct acceptance of SNF by CRWMS without repackaging
- Reduces contamination/low-level waste concerns at CRWMS facilities
- Reduces bare spent fuel handling operations
- Provides an additional containment barrier
- Simplifies CRWMS facilities (CMF, MRS, MGDS)
MPC Study -- Disadvantages

- Requires additional at-reactor operations
- Standardized system with large MPC not compatible with all reactor facilities
- Involves increase in cask fleet size
- Requires amendments to existing 10 CFR 961 standard contract
- Involves amendments to existing utility operating licenses
Issues and Future Activities -- Issues

- Industry issues
  - Standard contract (10 CFR Part 961)
  - Reactor facility upgrades

- MPC licensing issues
  - Burnup credit
  - Opening/Inspection requirements
  - Certification for utility use under General License
  - Licensing/Certification schedule
  - NRC issues

- Repository uncertainties
  - Canister filler material (nuclide retention, heat transfer)
  - Amount of shielding
  - Hot vs Cold
  - Performance credit for canisters
Issues and Future Activities -- Future Activities

• Continue interactions with utility industry
• Develop MPC conceptual design
• Develop Transportation overpack designs
• Refine system designs based on MPC concept