U.S. Department of Energy
Office of Civilian Radioactive Waste Management

# Operating the Waste Management System

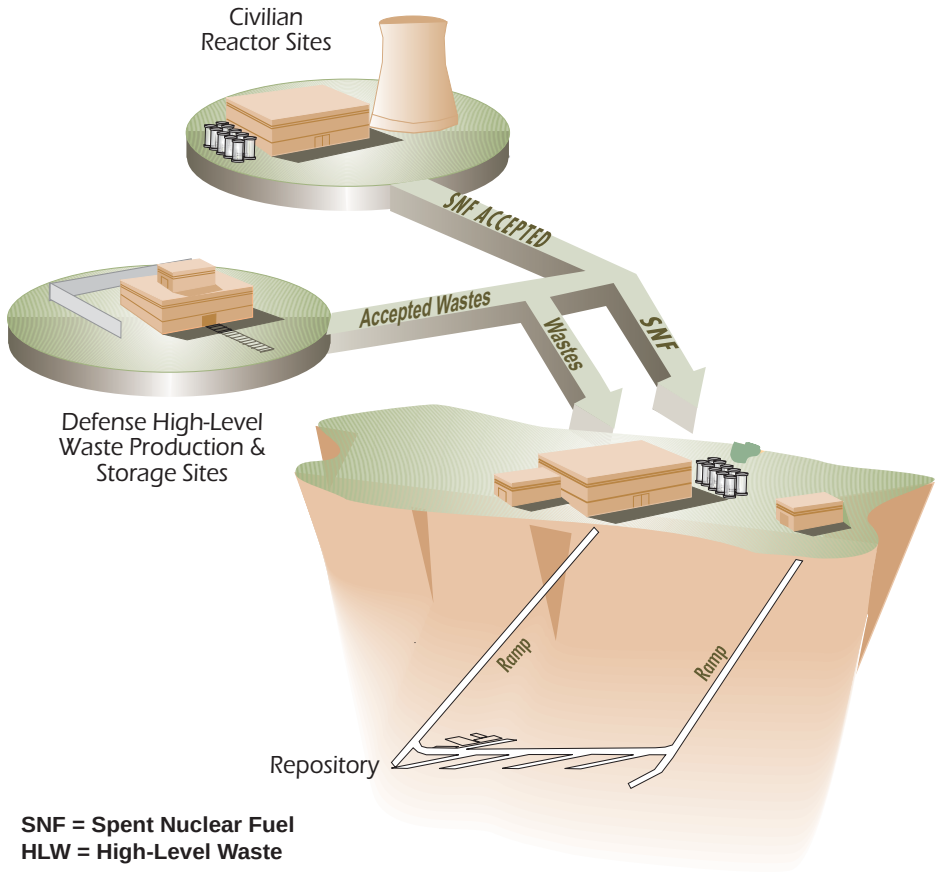
Presented to:
**Nuclear Waste Technical Review Board**

Presented by:
**Jeff Williams**
**Acting Director, Office of National Transportation**
**U.S. Department of Energy**

**January 28, 2003**
**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**

# U.S. Commercial SNF in 2010

- **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

1990* (SP)

2000 (DP)

2000

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

**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

| Year | Commercial SNF Target Receipt Rate |
|---|---|
| 2010 | 400 |
| 2011 | 600 |
| 2012 | 1,200 |
| 2013 | 2,000 |
| 2014 | 3,000 |

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

# *Waste Acceptance - Standard Contract Provisions*

- **Allocation 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**

# *Waste Acceptance - Standard Contract Provisions*

- **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**

# *Waste Acceptance - Standard Contract Provisions*

- **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**

# Operational Assumptions - Transportation Mode and Cask Fleet

## The final environmental impact statement (FEIS) studied two transportation scenarios:

| MOSTLY RAIL SCENARIO<br>Summary of Estimated Number of Shipments for National Transportation | | |
|---|---|---|
| | Truck | Rail |
| Proposed Action (24 years) | <1,100 | <10,000 casks<br><3,300 trains* |
| Annual | ≈45/yr | ≈400 casks/yr<br><135 trains/yr* |
| **Estimated Cask Fleet** | | |
| | Truck | Rail |
| Proposed Action | ≈10 | ≈90 |

| MOSTLY TRUCK SCENARIO<br>Summary of Estimated Number of Shipments for National Transportation | | |
|---|---|---|
| | Truck | Rail |
| Proposed Action (24 years) | <53,000 | ≈300 casks<br>≈100 trains |
| Annual | ≈2,200/yr | 12-13 casks/yr.<br><5 trains/yr. |
| **Estimated Cask Fleet** | | |
| | Truck | Rail |
| Proposed Action | ≈110 | N/A |

* Based on three rail casks per train shipment.

## FEIS states preference for rail, both nationally and in Nevada.

# Transportation Casks - Rail

**RAIL SPENT FUEL TRANPORTATION CASKS**

| Model (Type) | Vendor | Capacity (MTU)[1] | No. Built | Part 71 COC (Expires) | ALLOWABLE CONTENTS |
|---|---|---|---|---|---|
| MP-187 (Canister) | Transnuclear | 24P (10.56) | 1 | 9255 Rev 6 (9/03) | PWR: B&W 15x15 assemblies, <3.43 w/o U-235<br>5 to 8 years cooled, 30 GWD/MTU<br>9 to 17 years cooled, 40 GWD/MTU<br>PWR: WE 14x14 SStl clad assemblies, <4.05 w/o U-235<br>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.<br>Every type of standard fuel assembly can be transported.<br>PWR: 7 to 10 years cooled, 24.5 GWD/MTU<br>15 years cooled, up to 44.1 GWD/MTU<br>BWR: 8 years cooled, 24.5 GWD/MTU<br>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<br>(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<br>10 years cooled, 45 GWD/MTU, <3.7 w/o U-235<br>Max fuel assy length = 165”<br>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<br>25 years cooled, 60 GWD/MTU, <4.6 – 5.0 w/o U-235<br>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<br>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

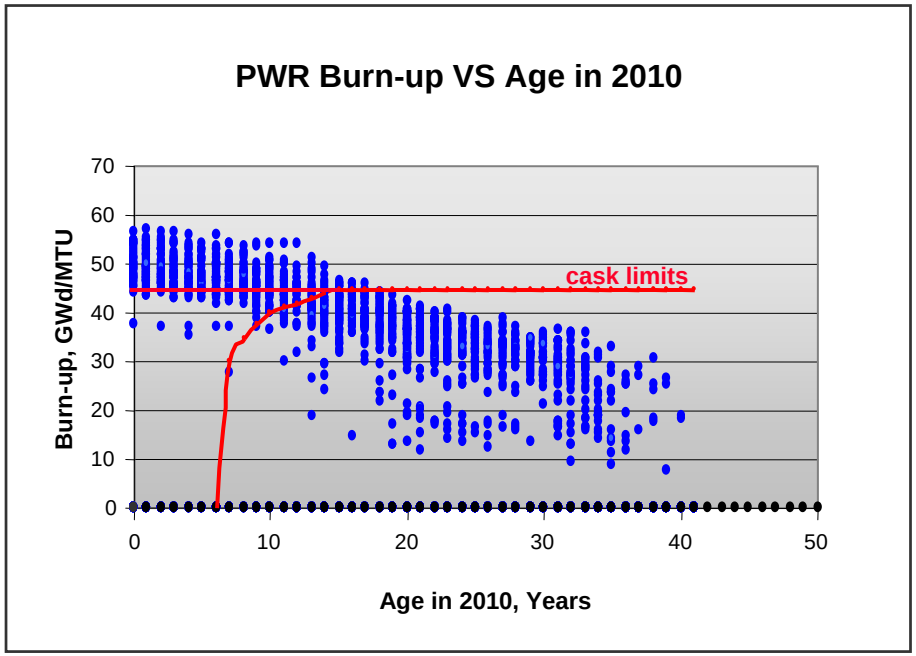
**TRUCK SPENT FUEL TRANSPORTATION CASKS**

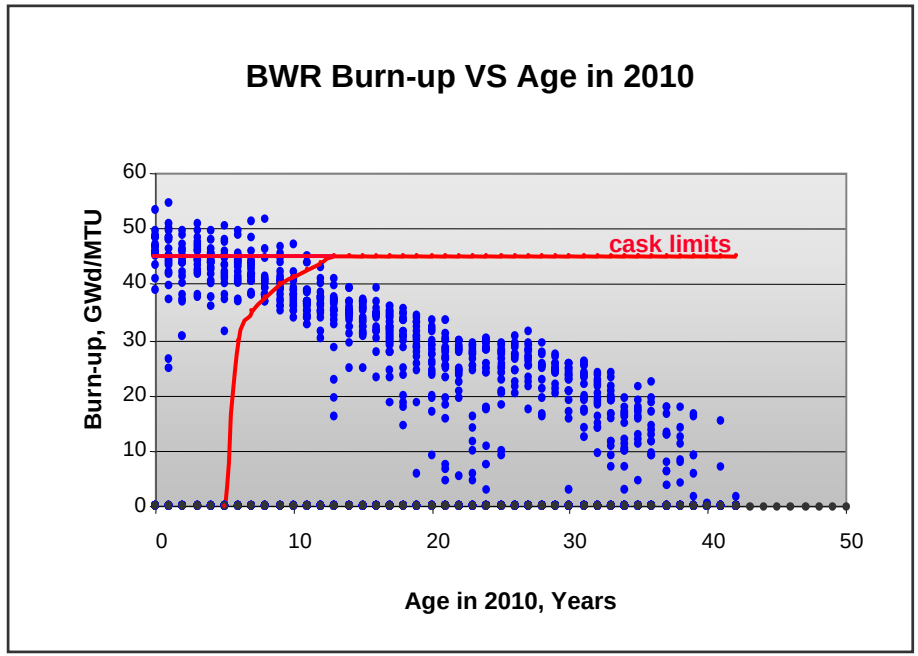
| Model | Vendor | Capacity (MTU)[1] | Number Built | Part 71 COC (Expires) | ALLOWABLE CONTENTS |
|---|---|---|---|---|---|
| NAC-LWT | NAC International | 1P/2B (.44/.37) | 8 | 9225 Rev 31 (2/05) | PWR: 2 years cooled, 35 GWD/MTU, <3.5 – 3.7 w/o U-235<br>BWR: 2 years cooled, 30 GWD/MTU, <4.0 w/o U-235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

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

# Pool Storage - Range of Fuel

**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**



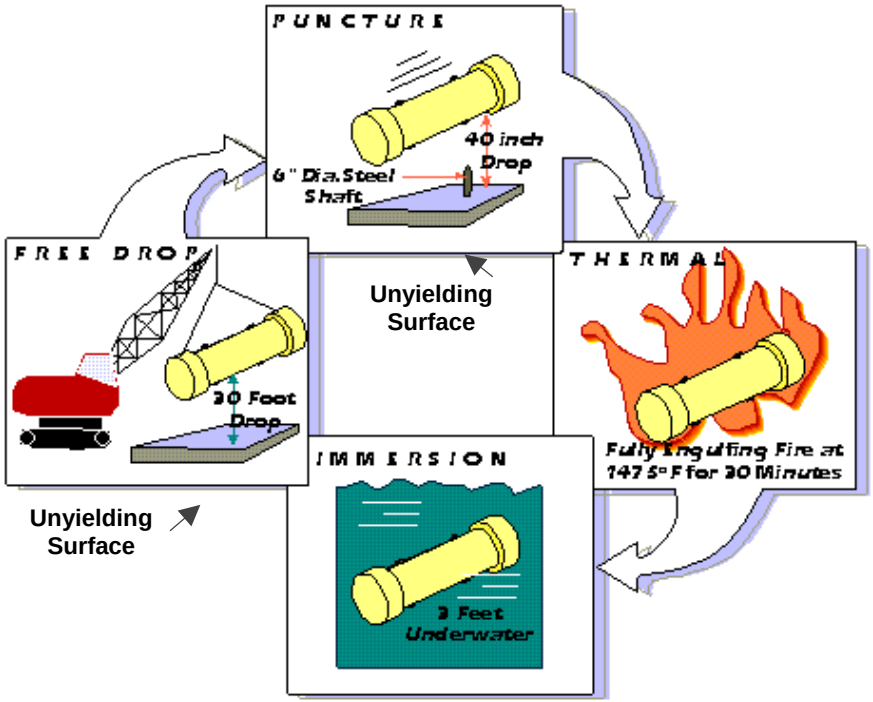



# *Transportation Equipment*

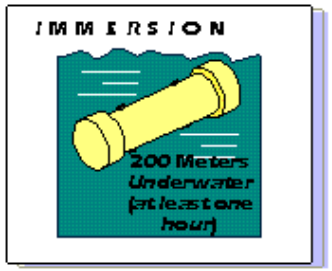
- **DOE will use existing, certified casks to the extent practicable**
- **Existing casks may need to be enhanced to transport higher burn-up and higher enriched SNF**
- **Recent industry emphasis on large rail casks**
- **For a mostly truck scenario, additional technology development is required**

# NRC Cask Performance Requirements

## *Hypothetical Accident Conditions*




## *Additional Test for SNF Casks*




- **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**

# Requirements Documents - Cask Requirements

- **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**

# Routing for OCRWM Shipments

- **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**

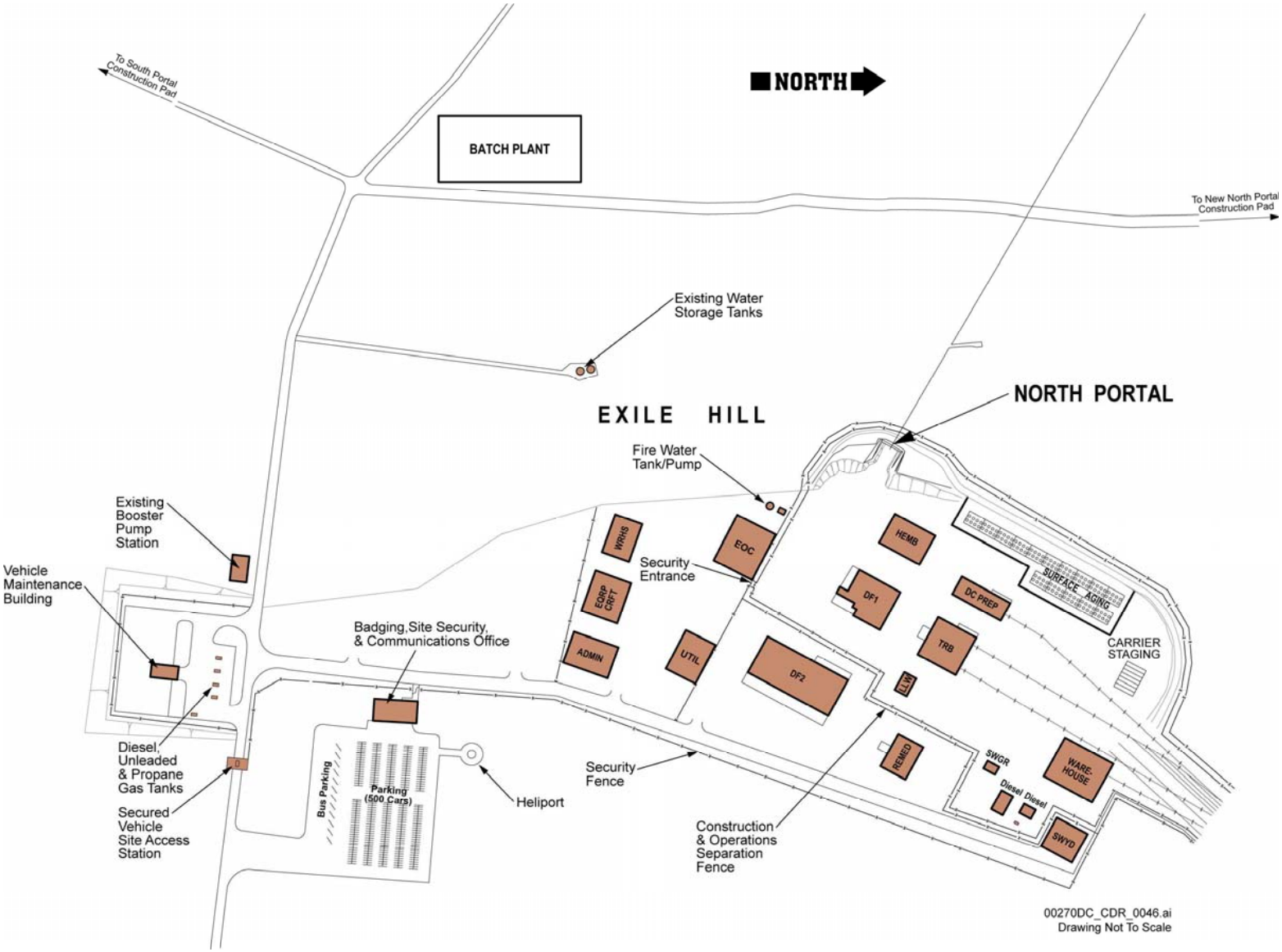
# Route Selection

- **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

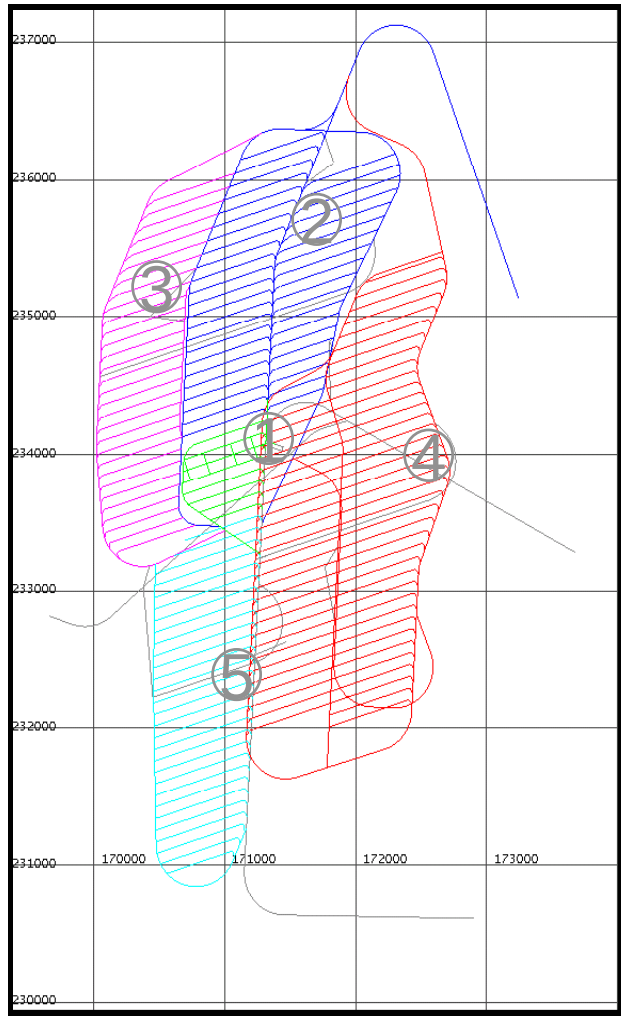
- **Thermal management plans are finalized prior to each shipment**
  - **may include blending (mixing of hotter and cooler fuel assemblies)**
  - **may include surface storage to age SNF**
- **Casks are received, surveyed, spotted and unloaded**
- **Packaging**
  - **Disposal**
    - **bare fuel is 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

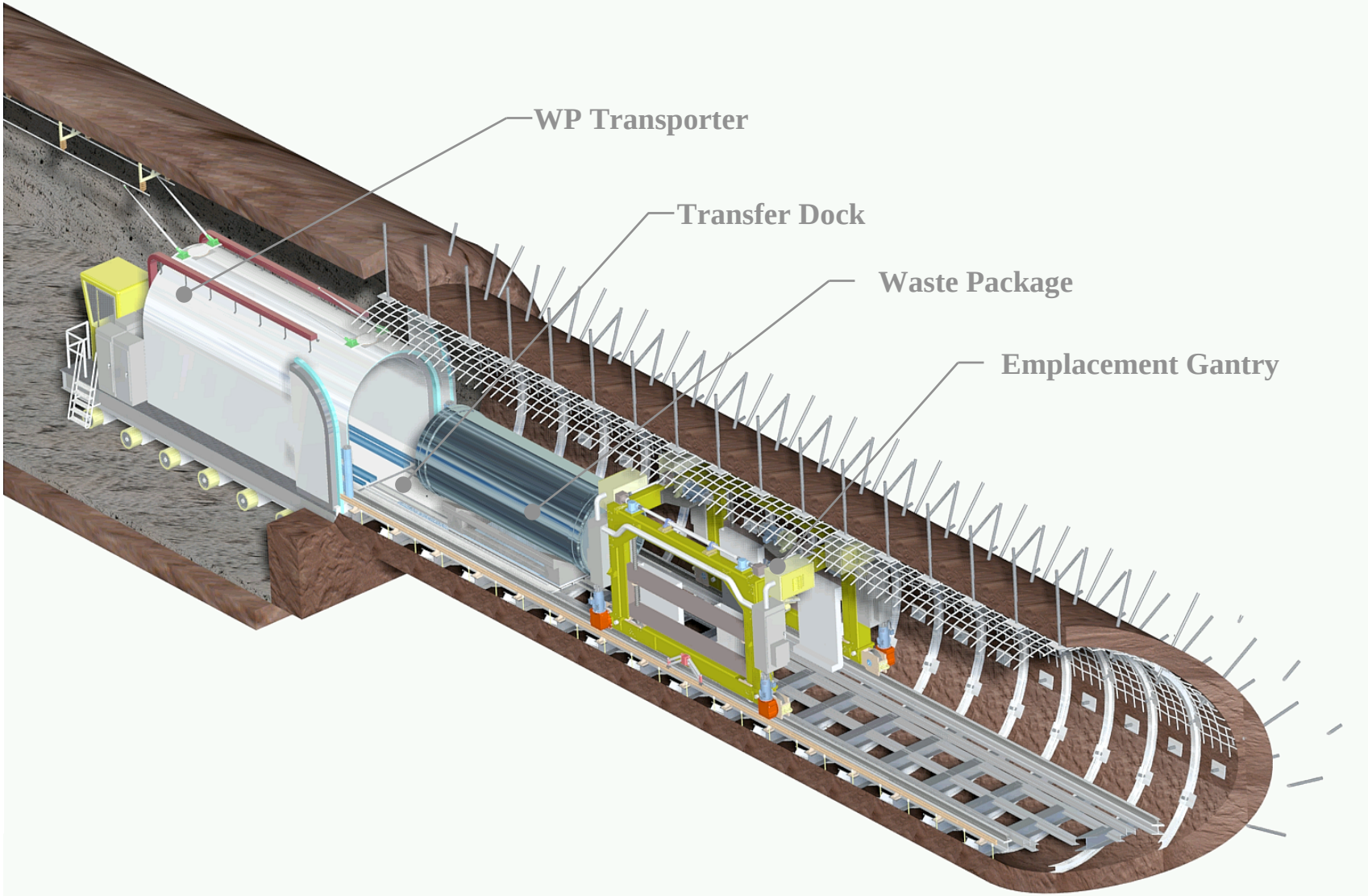


# Potential Underground Layout

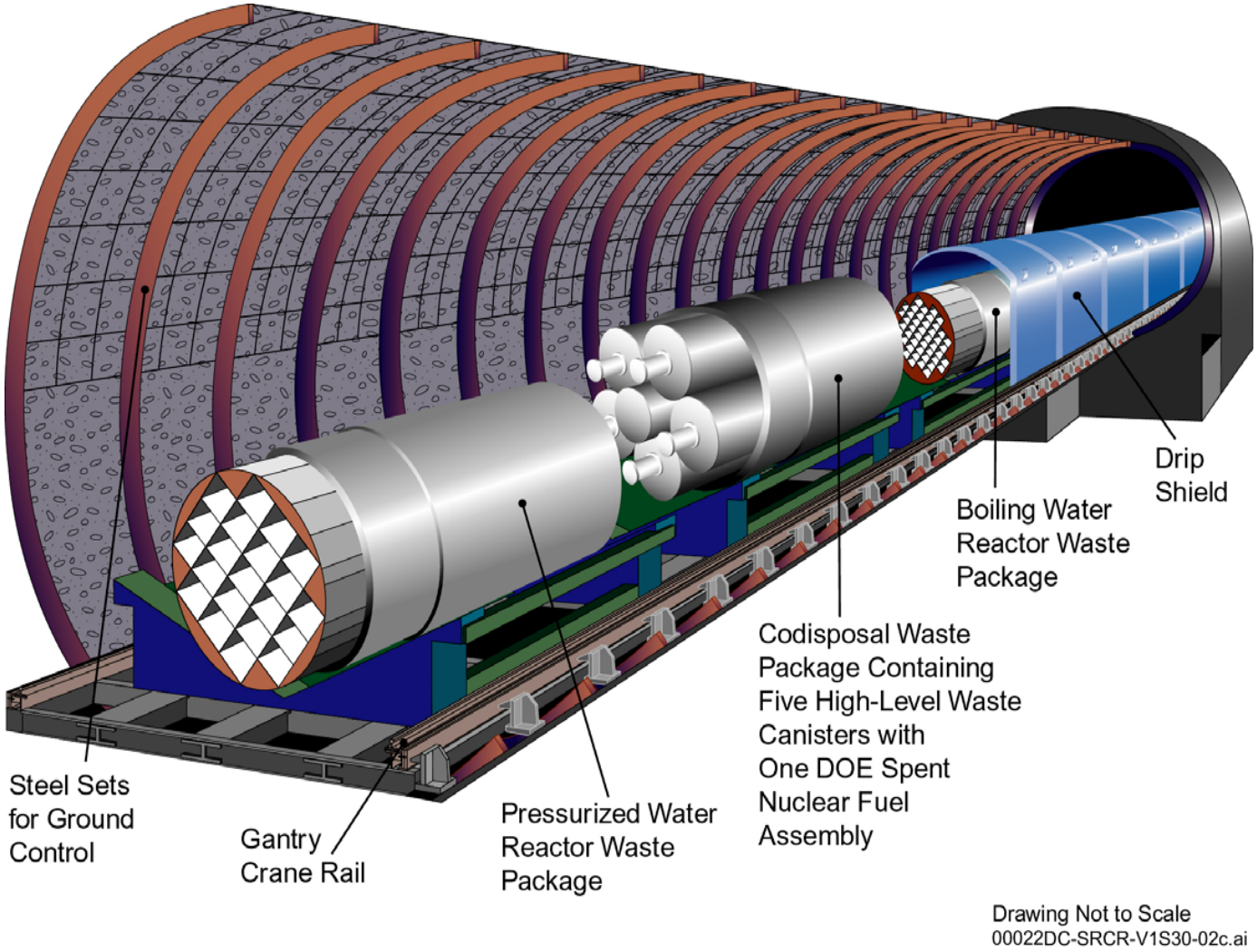
- **Modular panel layout**
  - **Panels 1-4 sufficient for 70,000 MTHM at up to 2 meter Waste Package spacing**
  - **Contingency of approximately 25% with addition of Panel 5**
  - **Improved ventilation scheme**
  - **Adds optional 3rd access ramp**
  - **Modular development allows "adaptive staging" 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



# Cutaway of a drift with three types of waste packages



# Summary

- 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