Evaluations of Removing Spent Nuclear Fuel from Shutdown Nuclear Power Plant Sites in the U.S.

Steven J. Maheras
Pacific Northwest National Laboratory

International Atomic Energy Agency
June 11-13, 2018
Vienna, Austria
Disclaimer

This is a technical presentation that does not take into account contractual limitations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961). Under the provisions of the Standard Contract, DOE does not consider spent fuel in multi-assembly canisters to be an acceptable waste form, absent a mutually agreed to contract amendment.

This presentation reflects research and development efforts to explore technical concepts which could support future decision making by DOE. No inferences should be drawn from this presentation regarding future actions by DOE.
The purpose is to support planning for removing spent nuclear fuel (SNF) and greater-than-Class C (GTCC) waste from shutdown nuclear power plant sites.

Collect and document information related to:
- Site inventory
- Site conditions
- Near-site transportation infrastructure and experience

Identify gaps in information that could hinder shipment of SNF and GTCC waste from the shutdown sites.

Identify options for transporting SNF and GTCC waste from the shutdown sites.
There will be 583 total canisters (546 SNF, 37 GTCC waste) at 14 shutdown sites

There are 11 dry storage systems in use at the shutdown sites; 9 transportation cask models would be used to remove SNF and GTCC waste from the sites

Locations of Shutdown Nuclear Power Plant Sites

- There will be 583 total canisters (546 SNF, 37 GTCC waste) at 14 shutdown sites
- There are 11 dry storage systems in use at the shutdown sites; 9 transportation cask models would be used to remove SNF and GTCC waste from the sites
## Characteristics of Shutdown Sites

<table>
<thead>
<tr>
<th>Site Location*</th>
<th>Reactor Type*</th>
<th>MWt&lt;sup&gt;b&lt;/sup&gt;</th>
<th>MWe&lt;sup&gt;c&lt;/sup&gt; (net)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Operating Period&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Current Status&lt;sup&gt;e,f&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine Yankee, Wiscasset, Maine</td>
<td>PWR</td>
<td>2700</td>
<td>860</td>
<td>1972-1996</td>
<td>DECON completed</td>
</tr>
<tr>
<td>Yankee Rowe, Rowe, Massachusetts</td>
<td>PWR</td>
<td>600</td>
<td>167</td>
<td>1961-1991</td>
<td>DECON completed</td>
</tr>
<tr>
<td>Humboldt Bay, Eureka, California</td>
<td>BWR</td>
<td>200</td>
<td>63</td>
<td>1963-1976</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>Big Rock Point, Charlevoix, Michigan</td>
<td>BWR</td>
<td>240</td>
<td>67</td>
<td>1963-1997</td>
<td>DECON completed</td>
</tr>
<tr>
<td>Rancho Seco, Herald, California</td>
<td>PWR</td>
<td>2772</td>
<td>873</td>
<td>1975-1989</td>
<td>DECON completed</td>
</tr>
<tr>
<td>Trojan, Rainier, Oregon</td>
<td>PWR</td>
<td>3411</td>
<td>1095</td>
<td>1976-1992</td>
<td>DECON completed</td>
</tr>
<tr>
<td>La Crosse, Genoa, Wisconsin</td>
<td>BWR</td>
<td>165</td>
<td>48</td>
<td>1969-1987</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>Zion 1, Zion, Illinois</td>
<td>PWR</td>
<td>3250</td>
<td>1040</td>
<td>1973-1997</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>Zion 2, Zion, Illinois</td>
<td>PWR</td>
<td>3250</td>
<td>1040</td>
<td>1974-1996</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>Crystal River, Crystal River, Florida</td>
<td>PWR</td>
<td>2609</td>
<td>860</td>
<td>1977-2009</td>
<td>SAFSTOR in progress</td>
</tr>
<tr>
<td>Kewaunee, Carlton, Wisconsin</td>
<td>PWR</td>
<td>1772</td>
<td>566</td>
<td>1974-2013</td>
<td>SAFSTOR</td>
</tr>
<tr>
<td>San Onofre-1, San Clemente, California</td>
<td>PWR</td>
<td>1347</td>
<td>436</td>
<td>1968-1992</td>
<td>SAFSTOR</td>
</tr>
<tr>
<td>San Onofre-2, San Clemente, California</td>
<td>PWR</td>
<td>3438</td>
<td>1070</td>
<td>1983-2013</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>San Onofre-3, San Clemente, California</td>
<td>PWR</td>
<td>3438</td>
<td>1080</td>
<td>1984-2013</td>
<td>DECON in progress</td>
</tr>
<tr>
<td>Vermont Yankee, Vernon, Vermont</td>
<td>BWR</td>
<td>1912</td>
<td>605</td>
<td>1972-2014</td>
<td>SAFSTOR in progress</td>
</tr>
<tr>
<td>Fort Calhoun, Fort Calhoun, Nebraska</td>
<td>PWR</td>
<td>1500</td>
<td>502</td>
<td>1973-2016</td>
<td>SAFSTOR in progress UNF removed from reactor vessel 11/13/2016</td>
</tr>
</tbody>
</table>
Total canisters = 583
Total SNF canisters = 546
Total GTCC canisters = 37
Total PWR canisters = 471
Total BWR canisters = 75
Inventory at Shutdown Sites (MTHM)

- Total MTHM = 6691.4
- Total PWR MTHM = 5862.9
- Total BWR MTHM = 828.5
- Total zirconium alloy clad MTHM = 6132.6
- Total stainless steel clad MTHM = 558.8

IAEA, June 11-13, 2018, Vienna, Austria
Inventory at Shutdown Sites (Assemblies)

Total assemblies = 19,227
Total PWR assemblies = 14,183
Total BWR assemblies = 5,044
Total zirconium alloy clad assemblies = 17,565
Total stainless steel clad assemblies = 1,662
Potential Future Shutdown Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Reactor Type</th>
<th>Location</th>
<th>MWt</th>
<th>MWe</th>
<th>Future Shutdown Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oyster Creek</td>
<td>BWR</td>
<td>Forked River, NJ</td>
<td>1930</td>
<td>619</td>
<td>10/31/2018</td>
</tr>
<tr>
<td>Pilgrim</td>
<td>BWR</td>
<td>Plymouth, MA</td>
<td>2028</td>
<td>677</td>
<td>06/01/2019</td>
</tr>
<tr>
<td>Three Mile Island</td>
<td>PWR</td>
<td>Middletown, PA</td>
<td>2568</td>
<td>819</td>
<td>09/30/2019</td>
</tr>
<tr>
<td>Indian Point-1</td>
<td>PWR</td>
<td>Buchanan, NY</td>
<td>615</td>
<td>257</td>
<td>10/31/1974</td>
</tr>
<tr>
<td>Indian Point-2</td>
<td>PWR</td>
<td>Buchanan, NY</td>
<td>3216</td>
<td>1020</td>
<td>04/30/2020</td>
</tr>
<tr>
<td>Indian Point-3</td>
<td>PWR</td>
<td>Buchanan, NY</td>
<td>3216</td>
<td>1040</td>
<td>04/30/2021</td>
</tr>
<tr>
<td>Davis-Besse</td>
<td>PWR</td>
<td>Oak Harbor, OH</td>
<td>2817</td>
<td>894</td>
<td>05/31/2020</td>
</tr>
<tr>
<td>Perry</td>
<td>BWR</td>
<td>Perry, OH</td>
<td>3758</td>
<td>1256</td>
<td>05/31/2021</td>
</tr>
<tr>
<td>Beaver Valley-1</td>
<td>PWR</td>
<td>Shippingport, PA</td>
<td>2900</td>
<td>921</td>
<td>05/31/2021</td>
</tr>
<tr>
<td>Beaver Valley-2</td>
<td>PWR</td>
<td>Shippingport, PA</td>
<td>2900</td>
<td>905</td>
<td>10/31/2021</td>
</tr>
<tr>
<td>Palisades</td>
<td>PWR</td>
<td>Covert, MI</td>
<td>2565.4</td>
<td>805</td>
<td>05/31/2022</td>
</tr>
<tr>
<td>Diablo Canyon-1</td>
<td>PWR</td>
<td>Avila Beach, CA</td>
<td>3411</td>
<td>1138</td>
<td>11/01/2024</td>
</tr>
<tr>
<td>Diablo Canyon-2</td>
<td>PWR</td>
<td>Avila Beach, CA</td>
<td>3411</td>
<td>1118</td>
<td>08/01/2025</td>
</tr>
</tbody>
</table>
### SNF Currently Stored at Potential Future Shutdown Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Reactor Type</th>
<th>Storage Docket</th>
<th>Vendor</th>
<th>System</th>
<th>Storage System Docket</th>
<th>Canister Type</th>
<th># Canisters</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oyster Creek</td>
<td>BWR</td>
<td>72-15</td>
<td>TN</td>
<td>Standardized NUHOMS</td>
<td>72-1004</td>
<td>61BT</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Oyster Creek</td>
<td>BWR</td>
<td>72-15</td>
<td>TN</td>
<td>Standardized NUHOMS</td>
<td>72-1004</td>
<td>61BTH</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Oyster Creek Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Pilgrim</td>
<td>BWR</td>
<td>72-1044</td>
<td>Holtec</td>
<td>HI-STORM 100</td>
<td>72-1014</td>
<td>MPC-68</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Three Mile Island</td>
<td>PWR</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>No ISFSI</td>
</tr>
<tr>
<td>Indian Point-1</td>
<td>PWR</td>
<td>72-51</td>
<td>Holtec</td>
<td>HI-STORM 100</td>
<td>72-1014</td>
<td>MPC-32</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Indian Point-2, -3</td>
<td>PWR</td>
<td>72-51</td>
<td>Holtec</td>
<td>HI-STORM 100</td>
<td>72-1014</td>
<td>MPC-32</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Indian Point Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Davis-Besse</td>
<td>PWR</td>
<td>72-14</td>
<td>TN</td>
<td>Standardized NUHOMS</td>
<td>72-1004</td>
<td>24P</td>
<td>3</td>
<td>Not transportable</td>
</tr>
<tr>
<td>Davis-Besse Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Perry</td>
<td>BWR</td>
<td>72-69</td>
<td>Holtec</td>
<td>HI-STORM 100</td>
<td>72-1014</td>
<td>MPC-68</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Beaver Valley-1, -2</td>
<td>PWR</td>
<td>72-1043</td>
<td>TN</td>
<td>Standardized NUHOMS</td>
<td>72-1004</td>
<td>37PTH</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Palisades</td>
<td>PWR</td>
<td>72-7</td>
<td>BFS/ES FuelSolutions</td>
<td>72-1004</td>
<td>VSC-24</td>
<td>18</td>
<td>Not transportable</td>
<td></td>
</tr>
<tr>
<td>Palisades Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Diablo Canyon-1, -2</td>
<td>PWR</td>
<td>72-26</td>
<td>Holtec</td>
<td>HI-STORM 100</td>
<td>72-1014</td>
<td>MPC-32</td>
<td>49</td>
<td>Site-specific license</td>
</tr>
</tbody>
</table>
Locations of Potential Shutdown Sites

- Diablo Canyon
- Palisades
- Davis-Besse
- Beaver Valley
- Three Mile Island
- Perry
- Pilgrim
- Indian Point
- Oyster Creek

IAEA, June 11-13, 2018, Vienna, Austria
General Types of Storage Systems Deployed at Shutdown Sites

**Vertical Concrete Casks (VCCs) Deployed at 9 Sites**

Vertical Concrete Casks at Maine Yankee

**Horizontal Storage Modules (HSMs) Deployed at 5 Sites**

Horizontal Storage Modules at Rancho Seco

**Underground Storage Modules at Humboldt Bay**

HI-STORM UMAX Underground Storage Modules

IAEA, June 11-13, 2018, Vienna, Austria
Transportation Cask Models That Would Be Used to Ship SNF and GTCC Waste from Shutdown Sites Have a Wide Range of Weights and Dimensions

Humboldt Bay
Kewaunee, Crystal River, San Onofre, and Fort Calhoun
Humboldt Bay

Kewaunee, Crystal River, San Onofre, and Fort Calhoun

Maine Yankee

Yankee Rowe, Connecticut Yankee, and La Crosse

Trojan and Vermont Yankee

Rancho Seco and San Onofre

Zion and Kewaunee

Big Rock Point

San Onofre

**HI-STAR HB**
- 128” dia.
- 230.8” long
- 187,000 lb.

**MP197HB**
- 126” dia.
- 271.25” long
- 304,000 lb.

**NAC-UMS UTC**
- 128” dia.
- 273.3” long
- 255,000 lb.

**NAC-STC**
- 128” dia.
- 273.7” long
- 255,000 lb.

**HI-STAR 100**
- 128” dia.
- 307.5” long
- 280,000 lb.

**MP187**
- 126.75” dia.
- 308.0” long
- 271,000 lb.

**NAC MAGNATRAN**
- 128” dia.
- 322.0” long
- 312,000 lb.

**TS125**
- 143.5” dia.
- 342.4” long
- 285,000 lb.

**HI-STAR 190**
- 128” dia.
- 362.06” long
- 421,000 lb.
Number of Canisters at Shutdown Sites Associated with Nine Transportation Cask Models

[Bar chart showing the number of canisters for different transportation cask models.]

- HI-STAR HB (Docket No. 71-9261): 6
- TS125 (Docket No. 71-9276): 8
- MP187 (Docket No. 71-9255): 40
- NAC-UMS UTC (Docket No. 71-9270): 64
- NAC-STC (Docket No. 71-9235): 64
- HI-STAR 190 (Docket No. 71-9323): 73
- MAGNATRAN (Docket No. 71-9356): 89
- HI-STAR 100 (Docket No. 71-9201): 94
- MP187HB (Docket No. 71-9302): 145

IAEA, June 11-13, 2018, Vienna, Austria
Sources of Information Used in Evaluation

- **Documents and Databases**
  - Public Documents, Historical DOE Documents, DOE Used Fuel Disposition Campaign Documents, Databases, Nuclear Industry Sources
  - DOE GC-859 Nuclear Fuel Survey Database
  - Facility Interface Data Sheets (FIDS), Services Planning Documents (SPDs), Facility Interface Capability Assessment reports (FICAs), and Near-Site Transportation Infrastructure reports (NSTIs)

- **Independent Spent Fuel Storage Installation (ISFSI) Site Managers**
  - Confirmed information obtained from other sources
  - Clarified current conditions at the shutdown sites
  - Provided photos and other detailed information

- **Heavy Equipment Lifting, Rigging, and Transporting Companies**
  - Provide information on large components moved on and off sites
• Shutdown site visits
  - Fourteen shutdown sites visited from August 2012 through May 2017
  - Confirmed aspects of inventories at the sites, obtained detailed inventory by canister, and canister load maps
  - Observed transportation infrastructure at and near sites
  - Detailed photos taken at sites
  - Information provided by the sites coupled with the opportunity to visit each site has been critical to DOE’s understanding of the conditions at and near the shutdown sites
  - Shutdown sites report sections describing each site are provided to each site for their review
  - Tribal, Federal Railroad Administration (FRA), State, and State Regional Group (SRG) representatives participate shutdown site visits and have provided valuable contributions to the evaluations

• Google Earth
  - Understand layout of shutdown sites
  - Used to provide detailed maps of shutdown sites and Independent Spent Fuel Storage Installations (ISFSIs)
  - Portray transload locations, and rail and heavy haul routes
Shutdown site inventories based on the GC-859 Nuclear Fuel Data Survey
- Most recent data through June 2013
- Number of spent nuclear fuel assemblies
- Metric tons heavy metal (MTHM)
- Discharge date, burnup, enrichment of spent nuclear fuel assemblies
- Many other SNF related parameters

Type and number of SNF storage systems (vendor and model) used at each site’s Independent Spent Fuel Storage Installation (ISFSI)
- Canisters containing SNF
- Canisters containing greater-than-Class C (GTCC) waste
- Loading maps, logs, etc.

Storage features/conditions
- Number of damaged fuel assemblies
- Number of high burnup fuel assemblies
- Canned/Not canned
- Loading maps show the specific locations of assemblies in canisters
- Used to determine realistic temperatures and dose rates
Onsite Conditions at Shutdown Sites

On-Site Transportation Features

- On-Site Rail
- On-Site Roads for Heavy Haul Trucks
- Barge Access

On-Site Equipment to Support Transportation Operations

- Transfer Casks
- Cranes and Rigging

On-Site Staging Areas for Transport Vehicles, Equipment, and Operations Support

Photo courtesy of Big Rock Point

Photo courtesy of La Crosse

Photo courtesy of Trojan

Photo courtesy of Big Rock Point
Evaluate transportation mode options for the shutdown sites

Near-Site Rail Access
- Condition and capacity of near-site rail infrastructure
- Potential transload locations
- Site experience with rail shipments

Local Roads and Highways
- Distance to potential rail transload locations (rail spurs or sidings)
- Characteristics and condition of roads and associated infrastructure that would be used by heavy haul vehicles
- Site experience with heavy haul shipments

Barge Access
- Characteristics of onsite or nearby docks/slips/shorelines
- Site experience with barge shipments
Potential Transload Locations Near Shutdown Sites

Portland Railhead Near Connecticut Yankee

Potential Kewaunee Transload Location Near Bellevue, Wisconsin

Petoskey Transload Location Near Big Rock Point

Gaylord Transload Location Near Big Rock Point
Potential Barge Locations

Barge Dock at Maine Yankee

Location of Barge Area in Coolant Discharge Canal at Connecticut Yankee

Barge Slip at Trojan

Barge Area at Crystal River
Site Experience Shipping Large Components Key to Understanding How SNF Might Be Moved

Turbine Component Unloading at Crystal River

Reactor Pressure Vessel Shipping at Maine Yankee

Reactor Pressure Vessel Shipping at La Crosse

Steam Generator Shipping Near Kewaunee
• Fort Calhoun site visit – May 15-19, 2017
• Met with Fort Calhoun staff (Omaha Public Power District, OPPD) and the Union Pacific Railroad
• Participants in site visit included
  • Federal Railroad Administration
  • Pahrump Paiute Tribe
  • Prairie Island Indian Community
  • Nebraska State Patrol
  • Nebraska Department of Health and Human Services
  • Iowa DOT Office of Rail Transportation
  • Iowa DOT Office of Motor Vehicle Enforcement
  • CSG-Midwest
Fort Calhoun has loaded 10 dry storage canisters containing 320 SNF assemblies into AREVA TN Standardized NUHOMS systems
- 32PT canisters
- Campaigns in 2006 (4 canisters) and 2009 (6 canisters)

Fort Calhoun will expand ISFSI to accommodate SNF currently in pool
- 944 assemblies
- Have damaged fuel and high burnup fuel
- Have not decided whether to stay with AREVA TN or switch to Holtec or NAC
- 30 additional dry storage canisters if stay with AREVA TN and 32PT canisters

Total of 40 SNF canisters and 1-2 GTCC canisters at conclusion of loadings (estimated)
Fort Calhoun Site Layout

Missouri River (border between Nebraska and Iowa)

Containment Building, Auxiliary Building, Turbine Building, Service Building, Radioactive Waste-Processing Building

Cargill Rail Spur

ISFSI
Fort Calhoun ISFSI
Fort Calhoun Served by Cargill Rail Spur and Union Pacific Railroad

Union Pacific Mainline in Blair, Nebraska

Cargill Plant

Fort Calhoun Site

Cargill Rail Spur

IAEA, June 11-13, 2018, Vienna, Austria
Track at Junction of Cargill Spur and Union Pacific Railroad

Looking South

Looking North
Track at Entrance to Cargill Spur

Looking South

Looking North

Derailer at Entrance to Spur

IAEA, June 11-13, 2018, Vienna, Austria
Cargill Railyard and 7.5-8 Degree Curve

IAEA, June 11-13, 2018, Vienna, Austria
Measuring Curvature of Track
Derailer and Greaser on Cargill Spur

Derailer and Greaser

Closeup of Greaser Activators
Cargill Rail Spur Onsite at Fort Calhoun

Cargill Rail Spur
Looking Southeast

Cargill Rail Spur
Looking Northwest
Cargill Rail Spur – 136 lb. rail, Concrete Ties, Pandrol Clips
Cargill Spur Still Active Down to Fort Calhoun Site
Rail Spur Used to Run Onsite

Cargill Rail Spur

Former Onsite Rail Spur

IAEA, June 11-13, 2018, Vienna, Austria
Fort Calhoun Barge Receiving Area
Fort Calhoun has received horizontal storage modules (HSMs) by rail on Cargill Spur.

HSMs transloaded onsite and moved down haul road to ISFSI.
HSM Transload and Transport to ISFSI Pad

Photos courtesy of Fort Calhoun
Installation of HSMs on ISFSI Pad

Photos courtesy of Fort Calhoun
Cargill Rail Spur, HSM Transload Location, and ISFSI

IAEA, June 11-13, 2018, Vienna, Austria
Current Condition of Transload Location and Haul Road
In 2006, two steam generators, the pressurizer, the reactor vessel head, low pressure turbines, and the main output transformer were replaced.

All equipment was shipped via barge except for main output transformer (shipped by rail).

During construction of the plant, major components were also shipped by barge.
Aerial View of Barge Area
Barge Transport on Missouri River and Arrival

Photos courtesy of Fort Calhoun
Barge Arrival and Offloading

Photos courtesy of Fort Calhoun
Reactor Vessel and Steam Generators Shipped by Barge During Construction

Photos courtesy of Fort Calhoun
## Summary of Transportation Mode Options Identified for Shutdown Sites

<table>
<thead>
<tr>
<th>Reactor Site</th>
<th>Transportation Mode Options</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine Yankee</td>
<td>Direct rail, Barge to rail</td>
<td>The condition of the onsite rail spur and Central Maine and Quebec Railroad would need to be verified.</td>
</tr>
<tr>
<td>Yankee Rowe</td>
<td>Heavy haul truck to rail, —</td>
<td>Potential rail transload location at east portal of the Hoosac Tunnel (7.5 miles from site).</td>
</tr>
<tr>
<td>Connecticut Yankee</td>
<td>Barge to rail, Heavy haul truck to rail</td>
<td>Depth of barge canal uncertain and may require dredging to accommodate barges. Potential rail transload location at Portland rail spur (12 miles from site).</td>
</tr>
<tr>
<td>Humboldt Bay</td>
<td>Heavy haul truck to rail, Heavy haul truck to barge to rail</td>
<td>Potential rail transload locations located 160 to 280 miles from site. The condition of the Fields Landing Terminal barge transload location would need to be verified.</td>
</tr>
<tr>
<td>Big Rock Point</td>
<td>Heavy haul truck to rail, Barge to rail</td>
<td>Potential rail transload locations in Petoskey, Michigan (13 miles from site) and Gaylord, Michigan (52 miles from site). The rail infrastructure at these locations would need to be evaluated.</td>
</tr>
<tr>
<td>Rancho Seco</td>
<td>Direct rail, —</td>
<td>The rail spur is not being maintained. Weight restrictions on the Ione Industrial Lead would require route clearance by the railroad.</td>
</tr>
<tr>
<td>Trojan</td>
<td>Direct rail, Barge to rail</td>
<td>The onsite rail spur was removed. Barge used to ship reactor pressure vessel and steam generators.</td>
</tr>
<tr>
<td>La Crosse</td>
<td>Direct rail, Barge to rail</td>
<td>The onsite rail spur was used to ship reactor pressure vessel.</td>
</tr>
<tr>
<td>Zion</td>
<td>Direct Rail, Barge to rail</td>
<td>The onsite rail spur was recently refurbished to support decommissioning.</td>
</tr>
<tr>
<td>Crystal River</td>
<td>Direct rail, Barge to rail</td>
<td>Extensive onsite rail system. Potential onsite barge area.</td>
</tr>
<tr>
<td>Kewaunee</td>
<td>Heavy haul truck to rail, Heavy haul truck to barge to rail</td>
<td>Potential rail transload locations in Bellevue, Luxemburg, Denmark, and Manitowoc. Potential barge transload location in city of Kewaunee.</td>
</tr>
<tr>
<td>San Onofre</td>
<td>Direct rail, Heavy haul truck to barge to rail</td>
<td>Onsite rail spur recently refurbished to support reactor decommissioning shipments.</td>
</tr>
<tr>
<td>Vermont Yankee</td>
<td>Direct rail, —</td>
<td>Onsite rail spur will be reactivated to support decommissioning.</td>
</tr>
<tr>
<td>Fort Calhoun</td>
<td>Direct Rail, Barge to rail</td>
<td>Onsite rail spur could be reinstalled or onsite transload performed. Barge used to ship steam generators, pressurizer, reactor vessel head.</td>
</tr>
</tbody>
</table>
Current Status – Shutdown Sites Evaluation

- Latest version of shutdown sites report (SSR) completed on September 30, 2017
- No new closures scheduled in FY2018 so no shutdown site visits scheduled for FY2018
- Continue to collect data on conditions at the shutdown sites
  - Add additional SNF discharge data
  - Add additional information on storage systems in use at shutdown sites
  - Add additional information on the local transportation infrastructure and transload locations around the shutdown sites
  - Evaluations of additional sites as they shut down, such as Oyster Creek, Pilgrim, Three Mile Island, Indian Point, Davis-Besse, Perry, Beaver Valley, Palisades, and Diablo Canyon