LESSONS LEARNED IN PLANNING FOR THE REMOVAL OF SPENT NUCLEAR FUEL FROM SHUTDOWN NUCLEAR POWER PLANT SITES IN THE U.S.

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Abstract

The U.S. Department of Energy Office of Spent Fuel and Waste Disposition continues to conduct evaluations of removing spent nuclear fuel from shutdown nuclear power plant sites. The evaluations of the 14 shutdown sites (Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, and Fort Calhoun) provide an important source of information that will be used in future planning for the removal of spent nuclear fuel from the sites. The lessons learned from the evaluations were organized into ten consistent themes. Several of the themes had to do with the shutdown site visits, such as the importance of safety, the importance of preparation for the site visits, the length of the questions submitted to the sites, the importance of using photographs to document site conditions, and the importance of compiling notes at the conclusion of each during a site visit. Several themes had to do with the collection of data, such as the use of Google Earth imagery, the importance of identifying issues associated with the spent nuclear fuel inventory, and the importance of capturing data and experience shortly after shutdown. The remaining themes had to do with building relationships with the shutdown sites and organizations such as Tribes, States, State Regional Group representatives, the Federal Railroad Administration, and local community engagement or advisory panels.

1. INTRODUCTION

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

In order to prepare for the transportation of spent nuclear fuel from the nuclear power plant sites to future storage or disposal facilities, evaluations of removing spent nuclear fuel from commercial nuclear power plant sites have been conducted, beginning with shutdown sites [1]. The shutdown sites currently include Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse,

Zion, Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, and Oyster Creek[1] (see Fig. 1). These sites have no other operating nuclear power reactors at their sites. Shutdown reactors at sites having other operating reactors were not included in this evaluation.

Figure 2 illustrates the number of canisters and type of storage canisters containing spent nuclear fuel and greater-than-Class C radioactive waste (GTCC waste)[2] that are stored or are anticipated to be stored at each of the shutdown sites. The number of canisters stored at Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, and Zion represent actual canisters in storage. The number of spent nuclear fuel canisters at San Onofre, Fort Calhoun, and Oyster Creek represents an estimate of the number of canisters that will be stored at the conclusion of canister loading and the number of canisters at Crystal River, Kewaunee, San Onofre, Vermont Yankee, Fort Calhoun, and Oyster Creek containing GTCC waste represents an estimate of the number of canisters generated during decommissioning. There are predicted to be a total of 663 canisters in storage at the 15 sites (actual plus estimated). The number of canisters ranges from 5 at La Crosse to 134 at San Onofre.

Figure 3[3] illustrates the number of spent nuclear fuel assemblies stored at each site. There are a total of 19,227 spent nuclear fuel assemblies present at the shutdown sites. These assemblies are composed of 14,183 pressurized water reactor assemblies and 5,044 boiling water reactor assemblies. The number of assemblies ranges from 333 at La Crosse to 3880 at Vermont Yankee. The majority (17,565) of the spent nuclear fuel assemblies are zirconium alloy-clad; but Yankee Rowe, Connecticut Yankee, La Crosse, and San Onofre-1 have a combined total of 1,662 stainless steel-clad spent nuclear fuel assemblies in storage.

Figure 4 illustrates the metric tons of heavy metal (MTHM) stored at each site. A total of 6691.4 MTHM of spent nuclear fuel at the shutdown sites consists of 5862.9 MTHM of pressurized water reactor spent nuclear fuel and 828.5 MTHM of boiling water reactor spent nuclear fuel.

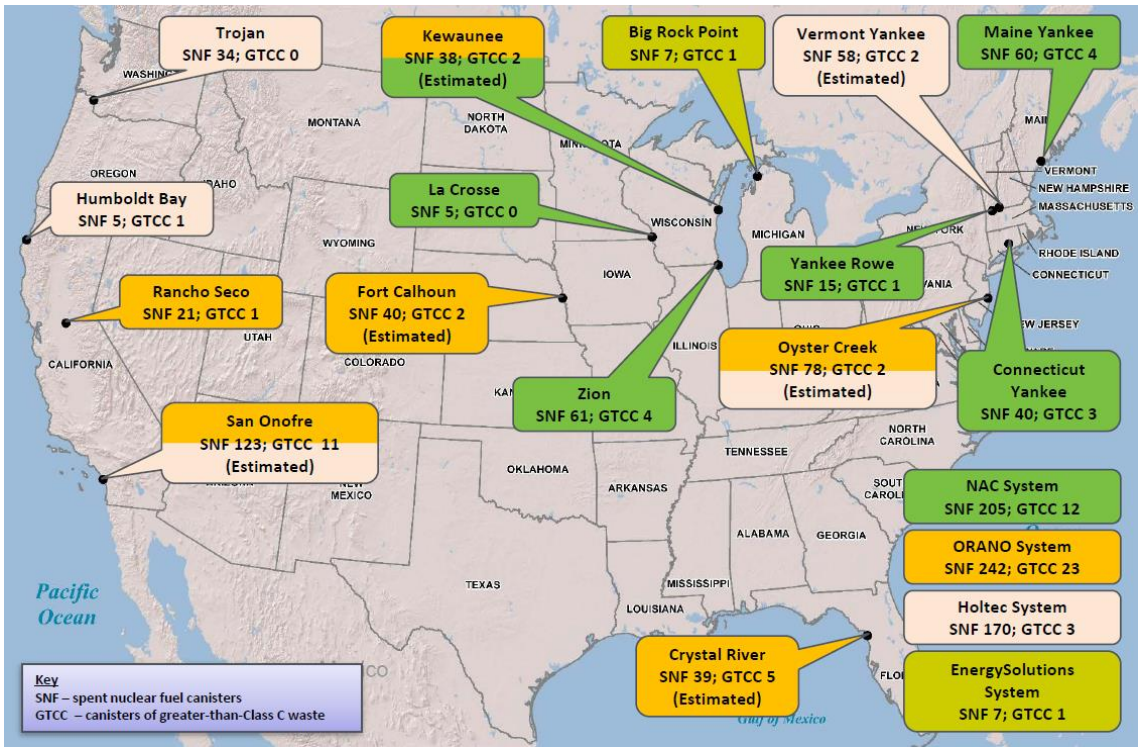

FIG. 1. Locations of shutdown sites.

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1 Oyster Creek is the fifteenth site to shut down and is not included in the evaluation. Oyster Creek will be included in the next update of the shutdown sites evaluation.

2 The U.S. Nuclear Regulatory Commission classification system for the four classes of low-level radioactive waste (A, B, C, and GTCC) is based on the concentrations of specific short and long-lived radionuclides. Classes A, B, and C are generally acceptable for disposal in near-surface land disposal facilities. GTCC waste is not generally acceptable for near-surface disposal.

3 Fig. 3 and Fig. 4 do not include data for Oyster Creek.

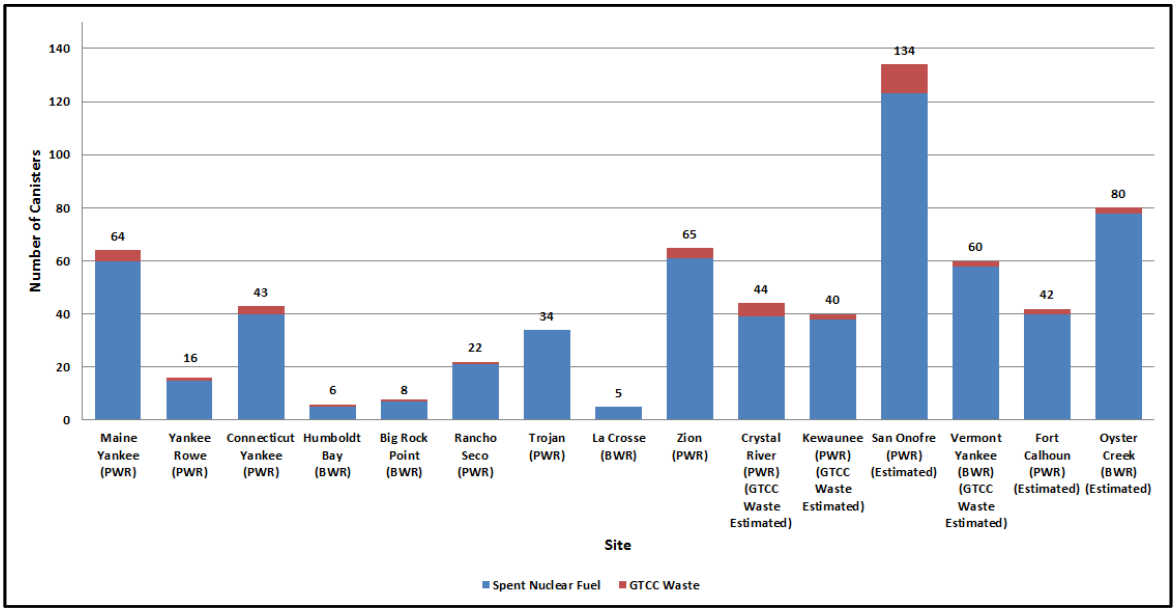

FIG. 2. Number of canisters at the shutdown sites.

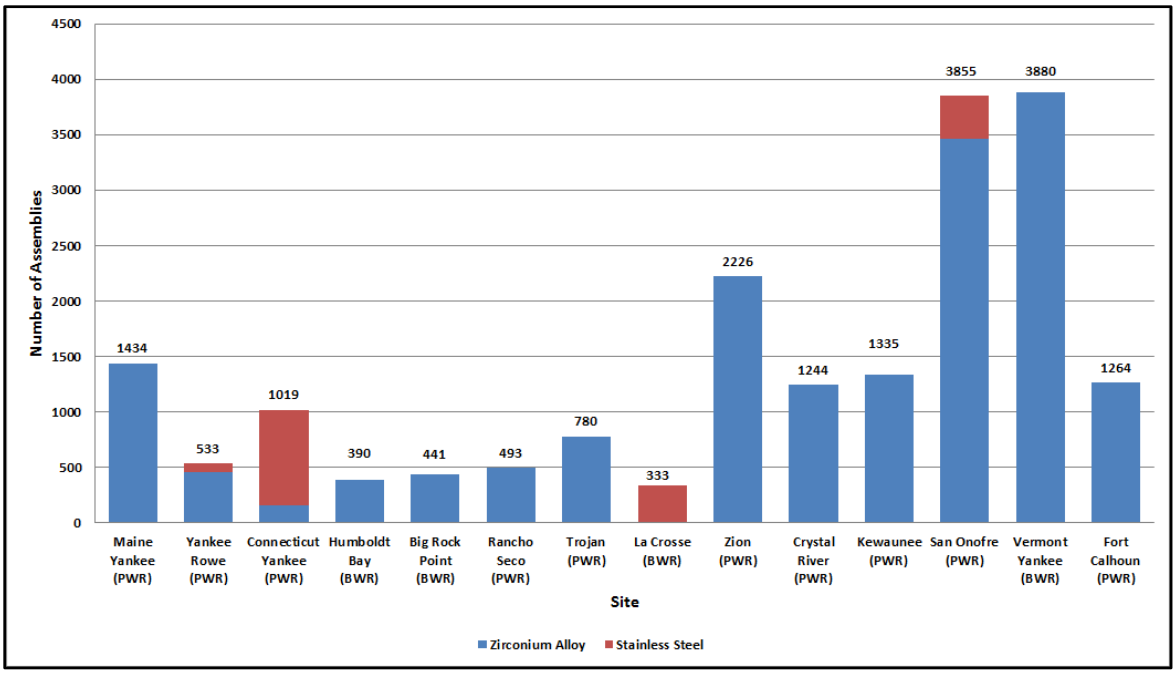

FIG. 3. Number of assemblies at the shutdown sites.

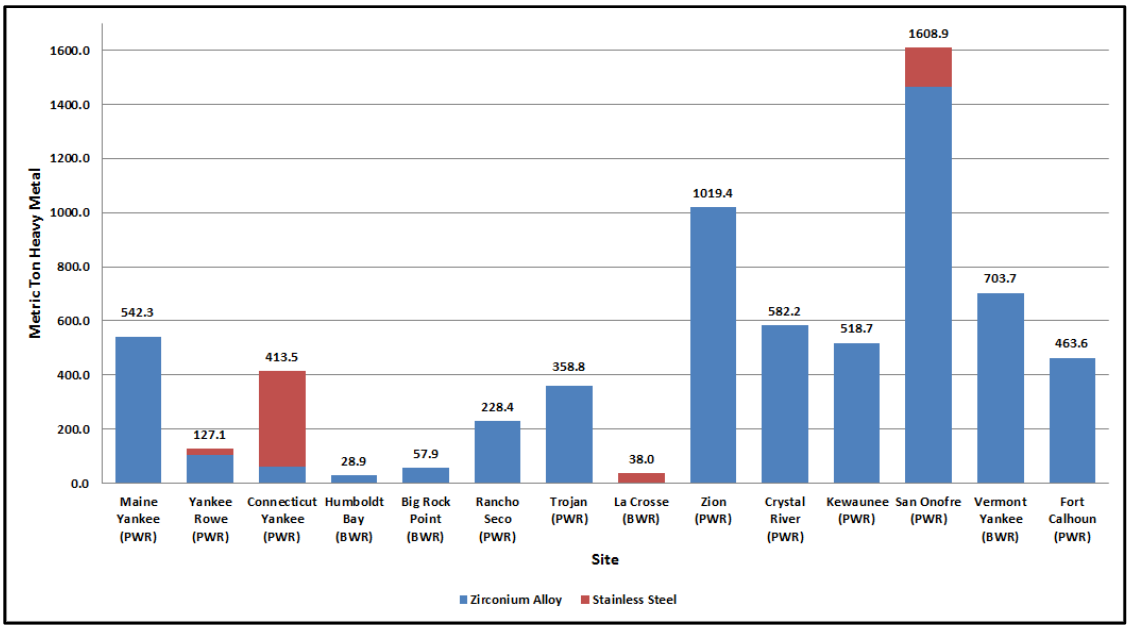

FIG. 4. Metric tons heavy metal at the shutdown sites.

2. METHODS

A wide variety of data sources have been used in conducting the evaluations of the shutdown sites. The primary sources for the inventory of spent nuclear fuel were the U.S. Department of Energy (DOE) GC-859 and RW-859 spent nuclear fuel inventory databases [2,3]. The databases contain information on the burnup, enrichment, and discharge date for each assembly stored at the sites. The GC-859 database is from 2013 and the RW-859 database is from 2002. Other supporting sources of data include:

— The original Environmental Impact Statement or Environmental Impact Report for the sites. These reports were typically published in the 1970s. Environmental impact statements or environmental impact reports are not available for sites that began operation in the early 1960s, before the passage of the National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.), such as Yankee Rowe, Humboldt Bay, and Big Rock Point.

— Environmental Impact Statements or Environmental Impact Reports for adjacent sites that were cancelled. For example, the Environmental Impact Statement for the Forked River Site, which was adjacent to the Oyster Creek site, was reviewed. The Forked River Environmental Impact Statement was published in 1973 but the reactor was cancelled in 1980.

— The License Renewal Environmental Impact Statement for the site.

— The Facility Interface Capability Assessments for each site. The purpose of these assessments was to determine the capability of each commercial nuclear power plant to handle various spent nuclear fuel shipping casks. Assessments were made of 122 facilities on 76 sites. The site visits associated with these assessments took place over the period 1987 through 1990.

— The Near-Site Transportation Infrastructure Assessments for each site. The purpose of these assessments was to identify the options available for transportation of spent nuclear fuel casks from each commercial nuclear power plant site to main transportation routes, such as interstate highways, commercial rail lines and navigable waterways available for commercial use. Assessments were made of 76 sites. The site visits associated with these assessments took place over the period 1989 through 1991.

— The Services Planning Document for each site. The purpose of the Services Planning Documents was to initiate the planning for shipping spent nuclear fuel from commercial nuclear power plant sites. Services Planning Documents were produced for 66 sites and are available for all currently shutdown sites, but not for all currently operating sites.

— The 2005 Facility Interface Data Sheet for the site. The purpose of the Facility Interface Data Sheets was to update the knowledge base concerning transportation interfaces with commercial nuclear power plant sites for removing spent nuclear fuel.
— Store Fuel. The industry publication Store Fuel contains information on the number, type, and model of dry storage systems and canisters at each shutdown and operating site.
— Newspaper archives. Newspaper archives often contain information on the shipping of large components to or from commercial nuclear power plant sites. For example, the Asbury Park Press contains articles and photographs of transformers being shipped to and from the Oyster Creek site by rail and by barge.
— Google Earth Imagery. Google Earth provides current imagery of features such as commercial nuclear power plant sites, independent spent fuel storage installations, roads, rail lines, potential transload locations, and barge slips or docks.

3. SITE VISITS

The objective of the site visits is to evaluate the onsite conditions at the site, evaluate the near-site transportation infrastructure at the site, evaluate potential transload locations, collect and document relevant site history from personnel before staffing is significantly reduced, and to understand the transportation experience at the site, especially for large components such as transformers and steam generators that are comparable in weight to a spent nuclear fuel transportation cask. Site visits typically take place over 2-3 days per site to accommodate interactions with the rail carriers and surveys of transload locations and rail lines.

3.1. First Three Site Visits

The first three site visits, to Maine Yankee, Yankee Rowe, and Connecticut Yankee, occurred over August 27-31, 2012. The first three site visits were limited to DOE personnel. Tribal and state representatives, State Regional Group (SRG) representatives,[4] and Federal Railroad Administration (FRA) representatives were not asked to attend and the railroads that served the sites were not contacted.

3.2. Next Six Site Visits

The next six site visits, to Trojan, Rancho Seco, Humboldt Bay, Zion, La Crosse, and Big Rock Point, occurred over July 14-19, 2013 and July 21-26, 2013. During these site visits, representatives from state governments, the Consolidated Group of Tribes and Organizations (CGTO), the Western Interstate Energy Board (WIEB), the Council of State Governments–Midwest (CSG-Midwest), and the FRA attended. Potential transload locations were evaluated and contacts with the rail carriers serving the sites were established.

3.3. Kewaunee and Crystal River Site Visits

The next two site visits were to Kewaunee and Crystal River. At both Kewaunee and Crystal River, contacts with the serving rail carriers were established and the length of the site visits was extended to 2-3 days per site to accommodate surveys of rail lines and transload locations.

During the Kewaunee site visit (September 8-12, 2014), the Oneida Nation of Wisconsin provided a detailed tour of the Oneida Reservation, including the Little Bear Development Center and the Language House. Representatives of the Oneida Nation, the Consolidated Group of Tribes and Organizations/Pahrump Paiute Tribe, the Wisconsin State Patrol, the Wisconsin Division of Emergency Management, the Council of State Governments–Midwest, and the Federal Railroad Administration attended the site visit. The Green Bay CN railyard was evaluated and meetings with the rail carrier staff were conducted. Potential transload locations at Luxemburg, Bellevue, Denmark, the Rockwood rail spur, and in Manitowoc, Wisconsin were also evaluated.

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4 The U.S. Department of Energy has cooperative agreements with four State Regional Groups and one tribal group to coordinate and resolve program-specific issues including transportation planning for spent nuclear fuel. The current cooperative agreement groups are the Southern States Energy Board, the Western Interstate Energy Board, the Council of State Governments–Midwest, the Council of State Governments–Eastern Regional Conference, and the Tribal Radioactive Materials Transportation Committee (TRMTC).

During the Crystal River site visit (February 17-20, 2015), representatives of the CGTO, the Southern States Energy Board, and the FRA attended the site visit. Representatives from the Florida Bureau of Radiation Control were invited to participate but were unavailable to attend. The Florida Northern Railroad rail line from the Crystal River site to Newberry, Florida was surveyed using a hi-rail vehicle and extensive photographs taken. The Crystal River Archaeological State Park, which contains a pre-Columbian Ceremonial Indian Mound Complex, was also visited.

3.4. San Onofre Site Visit

During the San Onofre site visit (June 1-6, 2015), representatives of the California Energy Commission, the CGTO, the WIEB, and the FRA attended the site visit. The San Onofre site is served by the Pacific Sun Railroad and has an onsite rail spur. The rail spur connects with the Pacific Sun Railroad mainline which is owned by the North County Transit District (NCTD). Amtrak Pacific Surfliner and Metrolink commuter rail service operate over the same track between Orange County and Oceanside, California, which limits freight service to 12:00 a.m. to 5:00 a.m. The Pacific Sun Railroad interchanges with the BNSF Railroad at the Stuart Mesa rail yard, which is located about 21 km south of the San Onofre site.

Meetings were held with retired BNSF railroad staff who had been involved with transporting radioactive material from the San Onofre site during the decommissioning of Unit 1 and with the Pacific Sun Railroad, which serves the San Onofre site. A meeting was also held with Bragg Crane and Rigging in Long Beach, California. Bragg Crane and Rigging provided significant insights into heavy-haul and barge transport at California nuclear power plant sites, and the specialized equipment that could be required.

During the San Onofre site visit, discussions were held with the officers of the San Onofre Community Engagement Panel. The San Onofre Community Engagement Panel is a volunteer, non-regulatory body established by Southern California Edison whose purpose is to enhance and foster open communication, public involvement and education on decommissioning activities at the San Onofre site. The Panel is comprised of representatives from legislative, business, and community groups to broadly reflect the diverse stakeholder viewpoints in proximity to the San Onofre site. During these discussions, the officers were briefed on DOE Office of Integrated Waste Management (DOE-IWM) activities, the evaluations of shutdown sites, and on the San Onofre site visit.

Discussions were also held with the NCTD, the owner of the mainline track that runs by the San Onofre site. As with the San Onofre Community Engagement Panel, the NCTD was briefed on DOE-IWM activities, the evaluations of shutdown sites, and on the San Onofre site visit. The 12:00 a.m. to 5:00 a.m. freight operation window on the NCTD mainline were discussed as well as bridge and track conditions, liability and risk, the number of shipments, security protocols, and perceptions of risk.

A subsequent site visit to San Onofre was also conducted. During this site visit (January 28-30, 2016), the current condition of the Del Mar Boat Basin on Camp Pendleton was evaluated. This location was used to offload steam generators that were shipped to the San Onofre site. Camp Pendleton personnel were also briefed on DOE-IWM activities and the evaluations of shutdown sites. A more extensive site visit to the Pacific Sun Railroad Stuart Mesa Railyard was also conducted.

3.5. Vermont Yankee Site Visit

During the Vermont Yankee site visit (May 9-13, 2016), representatives of the state of Vermont, the CGTO, the Council of State Governments–Eastern Regional Conference, and the FRA attended the site visit. Because the Vermont Yankee site is located close to New Hampshire and Massachusetts, representatives of the New Hampshire Homeland Security and Emergency Management Agency and the Massachusetts Emergency Management Agency also attended the site visit.

During the Vermont Yankee site visit, discussions were held with the New England Central Railroad (NECR), which serves the Vermont Yankee Site. These discussions included a briefing on DOE-IWM activities, shutdown site evaluations, and the Vermont Yankee site visit. The rail line from the Vermont Yankee site visit to Palmer, Massachusetts was preliminarily surveyed for potential overhead clearance, bridge weight, and turning radius issues using an NECR hi rail vehicle. Potential interchange locations with the CSX and Pan Am Southern and the NECR were also discussed.

Discussions were also held with the officers and other members of the Vermont Yankee Nuclear Decommissioning Citizens Advisory Panel (NDCAP). The Vermont Yankee NDCAP was established by state statute for the purpose of serving as a conduit for public information and education, to encourage open communication and community involvement in matters related to the decommissioning process of the Vermont Yankee site. The Vermont Yankee NDCAP also advises the Vermont Governor, General Assembly, state agencies, and the public on issues related to decommissioning. Although chartered by the state, the Vermont Yankee NDCAP does not have the authority to direct decommissioning at the Vermont Yankee site. As with the San Onofre Community Engagement Panel, discussions included a briefing on DOE-IWM activities, shutdown site evaluations, and the Vermont Yankee site visit. In a subsequent webinar held on June 28, 2018, DOE-IWM staff briefed the Vermont Yankee NDCAP on DOE-IWM work related to evaluating the removal of SNF from nuclear power plant sites, and DOE's initial site-specific de-inventory reports for Big Rock Point, Connecticut Yankee, Humboldt Bay, Kewaunee, Maine Yankee, and Trojan.

3.6. Fort Calhoun Site Visit

During the Fort Calhoun site visit (May 15 19, 2017), representatives of the Nebraska State Patrol, Nebraska Department of Health and Human Services, Iowa Department of Transportation Office of Rail Transportation, and the Iowa Department of Transportation Office of Motor Vehicle Enforcement, the CGTO, the Prairie Island Indian Community, the CSG-Midwest, and the FRA attended the site visit. Because the Fort Calhoun site is located on the border of Nebraska and Iowa, representatives from both Nebraska and Iowa attended the site visit.Rail service to the Fort Calhoun site is provided by the Union Pacific Railroad through the Cargill Industrial Spur. The Cargill Industrial Spur is on a right-of-way easement to the Union Pacific Railroad that follows the base of the bluff across the southern portion of the Fort Calhoun site and continues northwest to Blair, Nebraska where it joins the Union Pacific mainline. During the Fort Calhoun site visit, discussions were held with the Union Pacific Railroad. In addition, specific locations on the Cargill Industrial Spur were surveyed and evaluated. Fort Calhoun does not have a community engagement or advisory panel. During the site visit, Fort Calhoun staff indicated that formation of a community engagement panel was being considered; however, because Fort Calhoun is owned by the Omaha Public Power District and as a publicly owned utility already holds monthly public meetings, the site may use this existing mechanism for public engagement related to site decommissioning.

4. LESSONS LEARNED

Over the period 2012-2017, 14 shutdown site evaluations were conducted. Although each site is unique, there are 10 consistent themes that have been observed during the evaluations:

(a) Importance of safety. Site visits involve field work in nuclear and railroad environments. The railroad environment in particular has unique hazards. For this reason, morning safety briefings are conducted each day of a site visit and personal protective equipment is worn, as appropriate.

(b) Importance of preparation. The success of a site visit depends greatly on the background research performed prior to the site visit. This preparation takes the form of collecting and reviewing the data sources described in Section 2. Each site is unique, so after these documents are viewed, site-specific questions are developed and submitted to the site approximately one month prior to the visit. The site-specific questions are in the following areas:

- General site questions
- Operating and shutdown spent nuclear fuel management
- Site heavy load transportation experience, and on-site and near-site large/heavy load transportation infrastructure and capabilities.
- Cultural affiliation and tribal involvement.

Each shutdown site visit team member is typically assigned an area of responsibility and prepares the questions for their area. The questions are based on the questions used in the site visits for the Near-Site Transportation Infrastructure Assessments conducted during 1989-1991.

(c) Length of questions submitted to the sites. The length of the site-specific questions submitted to the shutdown sites has varied between 2-8 pages. Based on experience from the site visits, the optimum number of pages to gather necessary information without overwhelming the site staff, appears to be 4-6 pages.

(d) Importance of photographs to provide documentation of site conditions. Photographs taken during the site visits have been important in documenting conditions that exist to the shutdown sites. Photographs are typically geo-tagged to enable the files to be easily imported into DOE's Stakeholder Tool for Assessing Radioactive Transportation (START) web-geographic information system to visualize transportation routes and features like potential transload sites.

(e) Importance of compiling notes at the conclusion of each day. It has been the practice to review and compile the groups' notes from the site visits at the conclusion of each day, so that memories and recollections are fresh. This is done most efficiently in a group setting using a projector and screen. For this reason, a conference room is typically obtained at the site visit team hotel.

(f) Importance of tools such as Google Earth. During the site visits associated with the Facility Interface Capability Assessments and the Near-Site Transportation Infrastructure Assessments, a large number of paper maps were used. The availability of tools such as Google Earth has eliminated the need for paper maps and the imagery contained in Google Earth enables commercial nuclear power plant sites, independent spent fuel storage installations, roads, rail lines, potential transload locations, and barge slips or docks to be easily identified, mapped, and distances determined.

(g) Importance of identifying issues associated with the spent nuclear fuel inventory. 10 CFR 72.48 [4] allows a licensee or certificate holder to make changes in an independent spent fuel storage installation or spent nuclear fuel cask design as described in the final safety analysis report (FSAR); or in the procedures described in the FSAR; and conduct tests or experiments not described in the FSAR—provided that certain conditions are met. In addition, licensees may also request exemptions from the U.S. Nuclear Regulatory Commission (NRC) from the requirements contained in 10 CFR Part 72. These exemptions typically involve the requirements contained in 10 CFR 72.212 and 10 CFR 72.214. However, making these changes or requesting exemptions could result in a dry storage canister not being transportable as the canister might not meet the requirements contained in 10 CFR Part 71 [5]. This situation could likely be remedied through analysis and further licensing actions.

An example of this situation currently exists at the Rancho Seco site, where six damaged fuel assemblies are stored in five "fuel with control component dry shielded canisters" (FC-DSCs). When this fuel was originally packaged in canisters, the fuel was visually inspected and classified as damaged if cladding failures with breaches greater than 25 percent of the circumference of the fuel pin and at least the length of a fuel pellet were present. This equates to a cladding failure that is 8.6 mm across the cladding and 18 mm along the cladding. Fuel assemblies not classified as damaged using this definition were classified as intact. The current definition of intact fuel is more restrictive, where fuel assemblies are classified as intact if they contain no cladding breaches. Assemblies are classified as undamaged if they have no defects greater than hairline cracks or pinhole leaks. This change in the definition of damaged and intact fuel resulted in the six fuel assemblies formerly classified as intact being reclassified as damaged, using the new definition. The Rancho Seco storage license was amended to recognize this situation; however, the certificate of compliance for the MP187 transportation cask requires that damaged fuel assemblies be shipped in failed fuel dry shielded canisters (FF-DSCs), not in FC-DSCs, so the requirements for transporting the five FC-DSCs containing the six damaged fuel assemblies would need to be determined. In addition, the Safety Evaluation Report for the Rancho Seco independent spent fuel storage installation noted that visual examination alone is no longer a sufficient method for classifying assemblies as damaged or intact. The Safety Evaluation Report also stated that prior to transporting the used nuclear fuel stored at Rancho Seco, fuel classification may need to be revisited, and the damaged fuel assemblies (and potentially some fuel assemblies currently classified as intact) may need to be placed into damaged fuel cans to be transportable.

(h) Importance of capturing data and experience shortly after shutdown. The number of site personnel reduces dramatically, from roughly 600-800 to 120-150 in the 18-month period following shutdown. Further personnel reductions to less than 50 on-site may be encountered if the licensee decides to move the facility into long-term safe storage before decommissioning begins years later. Therefore, the collection of the data from the site could represent a challenge, as it may require a significant effort, and the data beyond what is required by the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste [6] and the GC-

859 spent nuclear fuel inventory database [2] may not be available in the satisfactory format. In addition, some data may no longer be available, due to the site closure and staff departures.

(i) The importance of building relationships with the shutdown sites. A key part of the shutdown site evaluations is the information obtained from personnel at the sites. Site personnel have provided data on the spent nuclear fuel to augment the data contained in the GC-859 and RW-859 databases, provided information on how large components were shipped on and offsite, provided photographs of past activities at their sites, and acted as hosts during site visits. As hosts, they have provided the opportunity to directly observe onsite infrastructure, spent nuclear fuel storage installations, and near-site transportation infrastructure. They have also provided the opportunity to take photographs at the site, which provides documentation of site conditions. In addition, through relationships with site personnel, DOE has been able to facilitate site tours by interested stakeholders.

(j) Including tribal and state representatives, SRG representatives, and FRA representatives in the site visits has increased the quality and quantity of the data collected during the site visits. For example, the FRA and State Rail Safety Participation Program representatives provide expertise in the five primary railroad safety technical disciplines—track, motive power and equipment, operating practices, signals and train control, and hazardous materials. The FRA also coordinates meetings with the rail carriers that serve the shutdown sites. State representatives typically represent their state department of energy, state department of environmental or natural resources, state police, state department of transportation, radiation protection organization, or emergency management organization, and provide expertise in these areas. Tribal representatives provide expertise associated with cultural affiliation and tribal involvement with past and present site activities. Including these organizations in site visits has also provided opportunities to build relationships with these organizations that will provide benefits in the future. In addition, conducting meetings with local community engagement or advisory panels has provided DOE-IWM the opportunity to inform these panels on DOE-IWM activities and the roles and responsibilities of federal agencies during site decommissioning, and also provides the opportunity to build relationships with these organizations that will provide benefits in the future.

5. CONCLUSIONS

Over the time period 2012-2017, 14 shutdown site evaluations were conducted. Ten consistent themes have been observed. Several of the themes had to do with the shutdown site visits, such as the importance of safety, the importance of preparation for the site visits, the length of the questions submitted to the sites, the importance of using photographs to document site conditions, and the importance of compiling notes at the conclusion of each day during a site visit. Several themes had to do with the collection of data, such as the use of Google Earth imagery, the importance of identifying issues associated with the spent nuclear fuel inventory, and the importance of capturing data and experience shortly after shutdown. The remaining themes had to do with building relationships with the shutdown sites and organizations such as Tribes, States, State Regional Group representatives, the Federal Railroad Administration, and local community engagement or advisory panels.

Finally, over the period 2019-2025, nine additional sites have announced they will be shutting down (see Fig. 5). As these sites shut down, they will be added to the DOE-IWM shutdown sites evaluation.

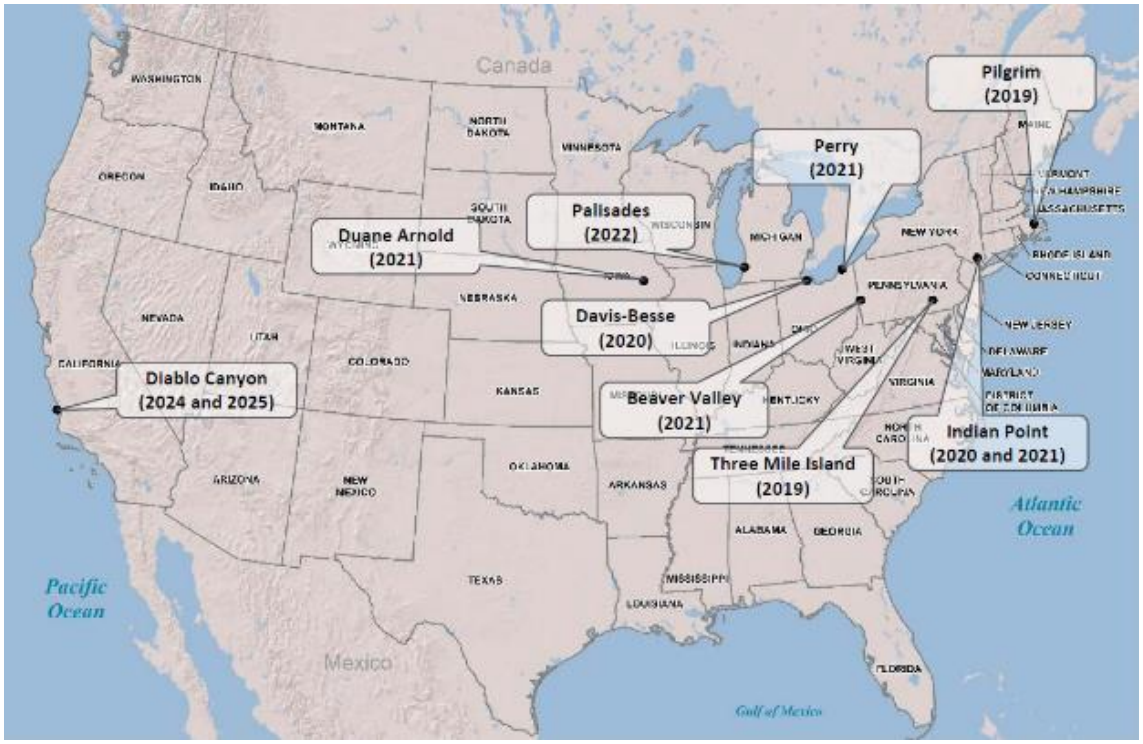

FIG. 5. Future shutdown nuclear power plant sites (2019-2025).

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