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Nuclear Fuels Storage & Transportation Planning Project
Office of Fuel Cycle Technologies
Nuclear Energy

Nuclear Fuels Storage and Transportation Planning Project – Transportation System Development Overview

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Western Interstate Energy Board
South Lake Tahoe, California
October 2014

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Outline

- NFST Transportation **Operational** Activities
  - Shutdown Sites Report
  - UNF ST&DARDS
- NFST Transportation **Hardware** Activities
  - AAR S-2043 Compliant Railcar Development
- Linking it All Together

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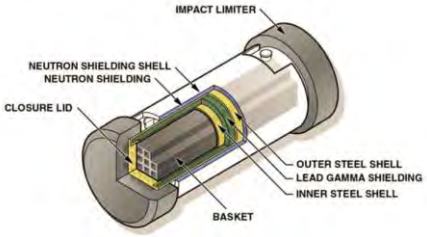
Transportation System Organization

- **Historically, the development of a transportation system has been divided into three primary elements**
  - Institutional
    - Relationships that must be established with stakeholders to move the transportation process forward
      - States, Tribes and Local Officials
      - First Responders
      - Industry
      - Carriers, etc.

  - Operational
    - Day-to-day activities that will take place to operate the transportation system
  - Hardware
    - All physical items that must be used in order to operate the transportation system
      - Casks
      - Railcars
      - Heavy-haul trailers, etc.



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Operational Activities are Ramping Up with Focus on the Shutdown Sites

- **Development of the Stakeholder Tool for Assessing Radioactive Transportation (START)**
  - Development of START is considered an Operational activity, though support for use of START by Stakeholders is considered an Institutional Activity
  - START Version 1.1 released 9/30/2014
  - Training provided at AD Hoc 180(c) meeting in Atlanta last week

- **Review of Recommendations by NAS to determine ownership and progress**
- **Shutdown Sites Report continues to develop**
- **UNF ST&DARDS Development**
  - Specific to transportation

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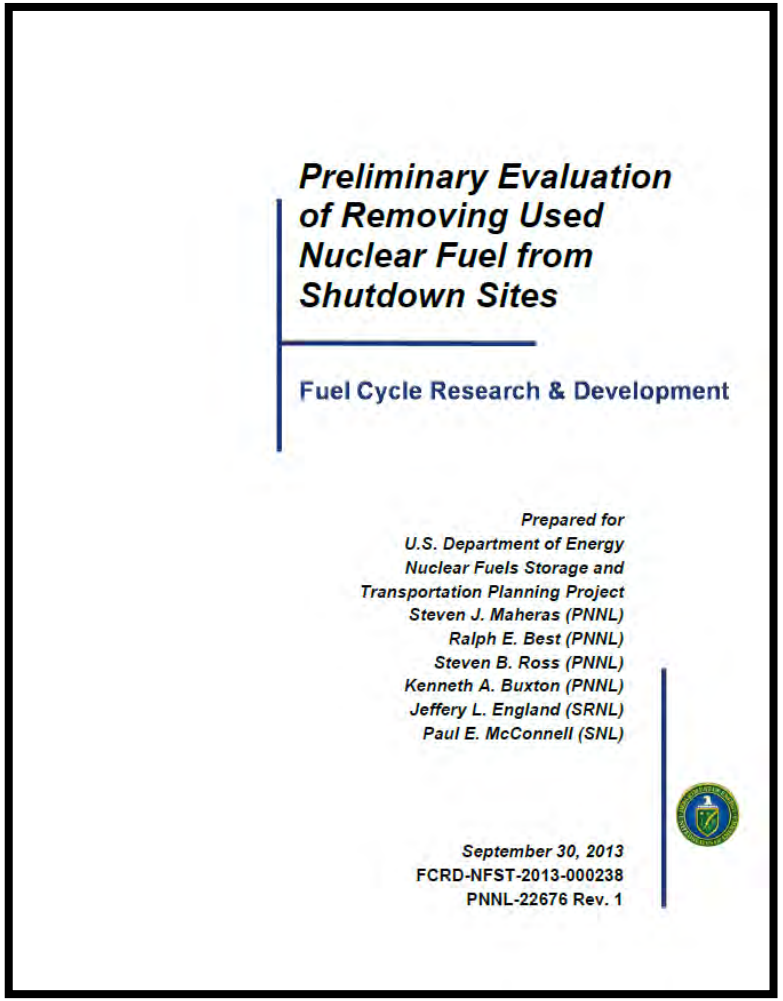
Current Status of Shutdown Sites Activities

- **Latest Shutdown Sites Report (SSR) released on August 30, 2014**
- **In-Process of being posted on DOE-NE website**
  - http://energy.gov/ne/downloads/preliminary-evaluation-removing-used-nuclear-fuel-shutdown-sites
- **NFST has visited 10 Shutdown Sites**
  - SRG representatives, a Tribal representative, and a Federal Railroad Administration (FRA) representative participated in 7 of the shutdown site visits
  - Kewaunee site visit completed 09/09-09/11/2014



Preliminary Evaluation of Removing Used Nuclear Fuel from Shutdown Sites

Fuel Cycle Research & Development

Prepared for
U.S. Department of Energy
Nuclear Fuels Storage and Transportation Planning Project
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September 30, 2013
FCRD-NFST-2013-000238
PNNL-22676 Rev. 1

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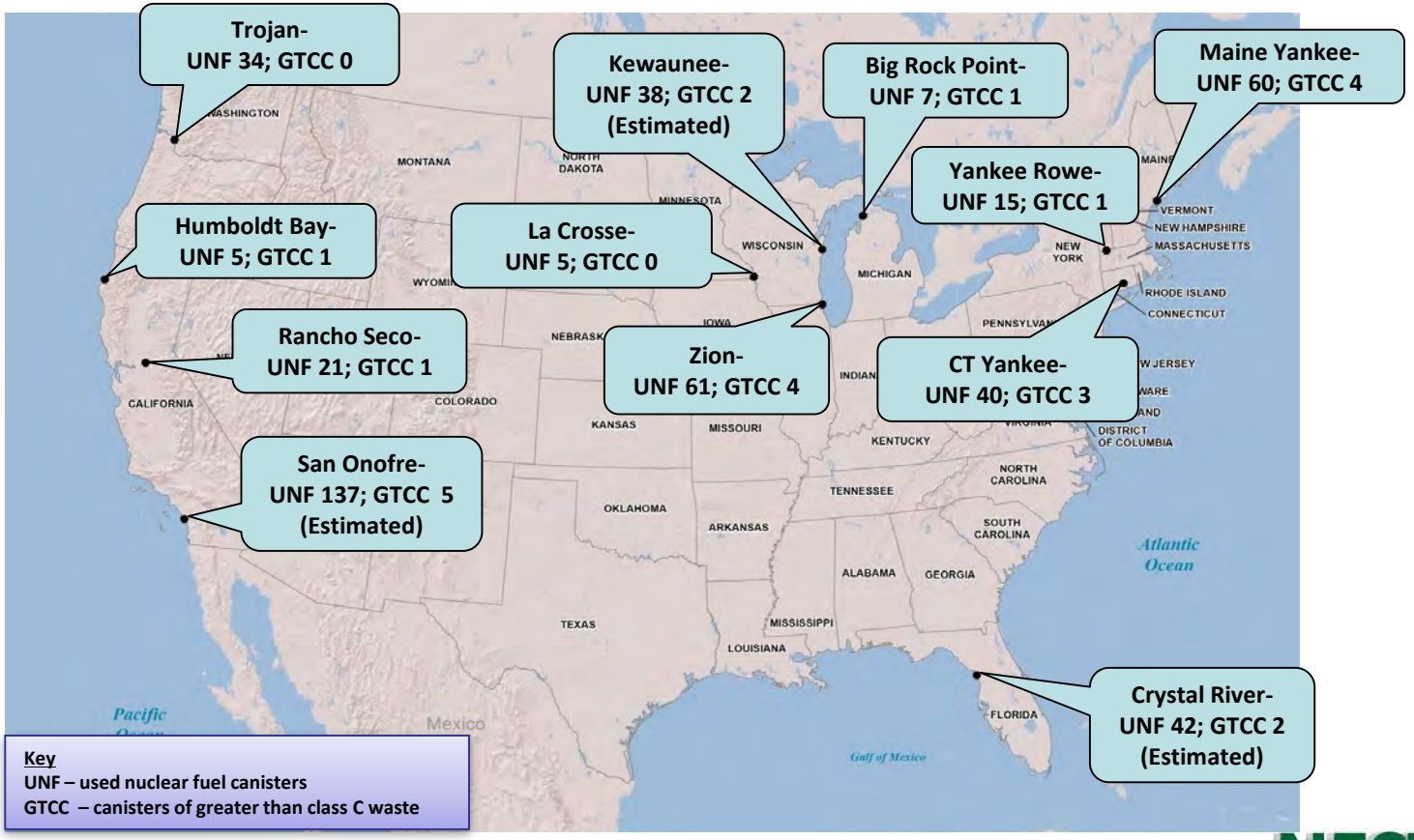
Locations of 12 Shutdown Reactor Sites

- **Nine Storage System Types and Eight Different Transportation Cask Designs at Shutdown Sites**



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Trojan

- **Portland and Western Railroad passes through the Trojan site**
  - Portland and Western interchanges with BNSF and UP near Portland, Oregon
- **Rail is Track Class 2 in vicinity of site**
- **Rail spur to site removed**
- **Smaller spur installed for waste shipments during decommissioning but has been removed**
- **Onsite barge slip**

Trojan ISFSI

Trojan Site Layout

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Trojan Transportation Infrastructure

Portland and Western Railroad Outside Trojan Site

Junction of Portland and Western Railroad and Trojan Onsite Rail Spur

Trojan Onsite Rail Spur Bed

Remnants of Onsite Rail Spur at Trojan Site

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Trojan Barge Slip

- Trojan barge slip used to remove steam generators (450 tons each), pressurizer (125 tons), and reactor pressure vessel (1000 tons) during decommissioning

Steam Generator at Trojan Barge Slip

Trojan Access Road and Barge Slip

Trojan Barge Slip Access Road

Trojan Barge Slip

Humboldt Bay

- **Humboldt Bay has not been served by rail since 1998**
  - Was served by Northwestern Pacific Railroad
  - Northwestern Pacific open to Windsor, California, about 220 miles south of Humboldt Bay
- **No onsite barge access**

Humboldt Bay ISFSI

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Humboldt Bay Site Layout

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Potential Humboldt Bay Heavy Haul Routes

- **Nearest rail access located in Redding, California**
- **During decommissioning, Humboldt Bay has used several truck routes**
  - U.S. Highway 101 south to California State Route 20 to Interstate 5
  - U.S. Highway 101 north to U.S. Highway 199 to Interstate 5
  - U.S. Highway 101 north to California State Route 299 to Interstate 5
- **Distance to these locations range from 160-260 miles**
- **Other locations are possible**
  - Coos Bay, Oregon – 220 miles
  - San Francisco Bay Area – 290 miles

Rail Access	Route	Heavy Haul Distance (miles)
Grants Pass, Oregon	U.S. Highway 101 to U.S. Highway 199	180
Redding, California	U.S. Highway 101 to State Route 299	160
Red Bluff, California	U.S. Highway 101 to State Route 36	160
Williams, California	U.S. Highway 101 to State Route 20	230
Marysville, California	U.S. Highway 101 to State Route 20	260

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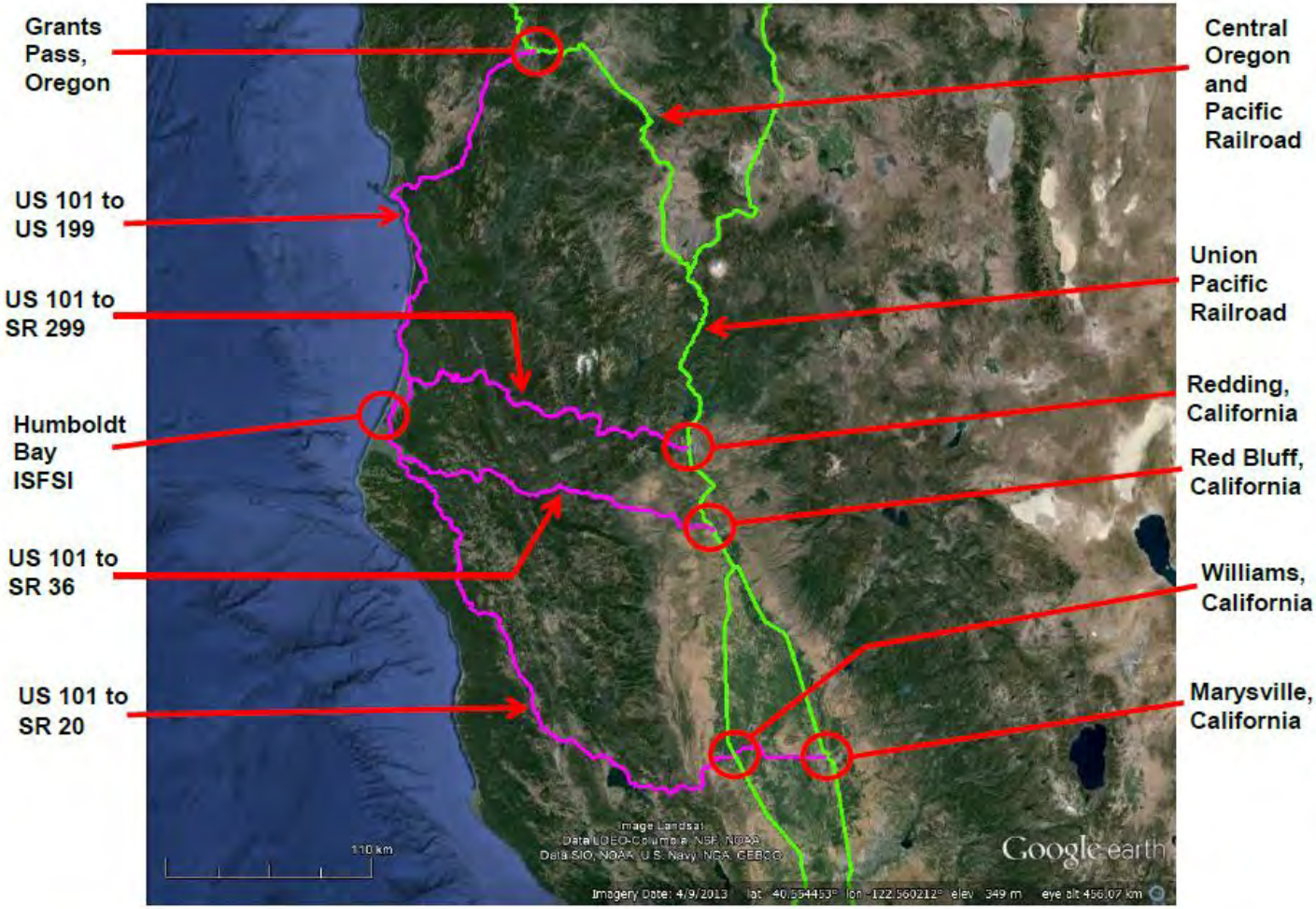
Humboldt Bay Potential Heavy Haul Routes



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Humboldt Bay Barge Access

- **Humboldt Bay has no onsite barge access**
- **Fields Landing Terminal, located 2 miles south of Humboldt Bay, was used to offload 10 engines and generators that were installed at the Humboldt Bay Generating Station**
  - Engines – 680,000 lb. each
  - Generators – 150,000 lb. each
- **Heavy haul trucks used to transport engines and generators from Fields Landing to Humboldt Bay**

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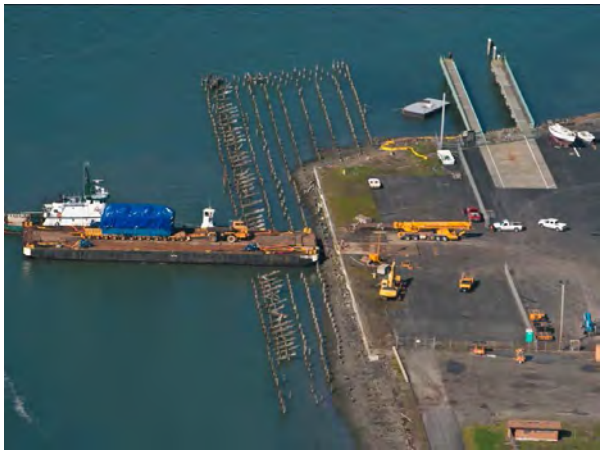
Engine and Generator Transport to Humboldt Bay Site

Loading Engine Onto Barge at Schneider Dock



Engine Arriving at Fields Landing Terminal

Unloading Engine at Fields Landing Terminal

Engine Arriving at Humboldt Bay Site

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Engine and Generator Heavy Haul Route to Humboldt Bay Site

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Rancho Seco

- **Onsite rail spur connects to Union Pacific Ione Industrial Lead**
- **Ione Industrial Lead connects to Union Pacific mainline in Galt, California**
  - Mainline connects Stockton and Sacramento
- **Ione Industrial Lead is Track Class 2**
  - 158 ton weight limit
  - 6-axle locomotives prohibited
  - Transport of UNF and GTCC would require route clearance
- **UP mainline is Track Class 5**
- **Rail spur used during decommissioning but is not being maintained**
  - Rail spur was used to transport four reactor coolant pumps (50 tons each), the pressurizer (150 tons), and two steam generators (550 tons each)
  - The two steam generators were too large to ship in their intact state due to rail route clearances and were cut into four 225-ton segments
- **During decommissioning, heavy haul truck to barge transport was used to transport 520-ton generator to Surry for re-use**

Rancho Seco ISFSI

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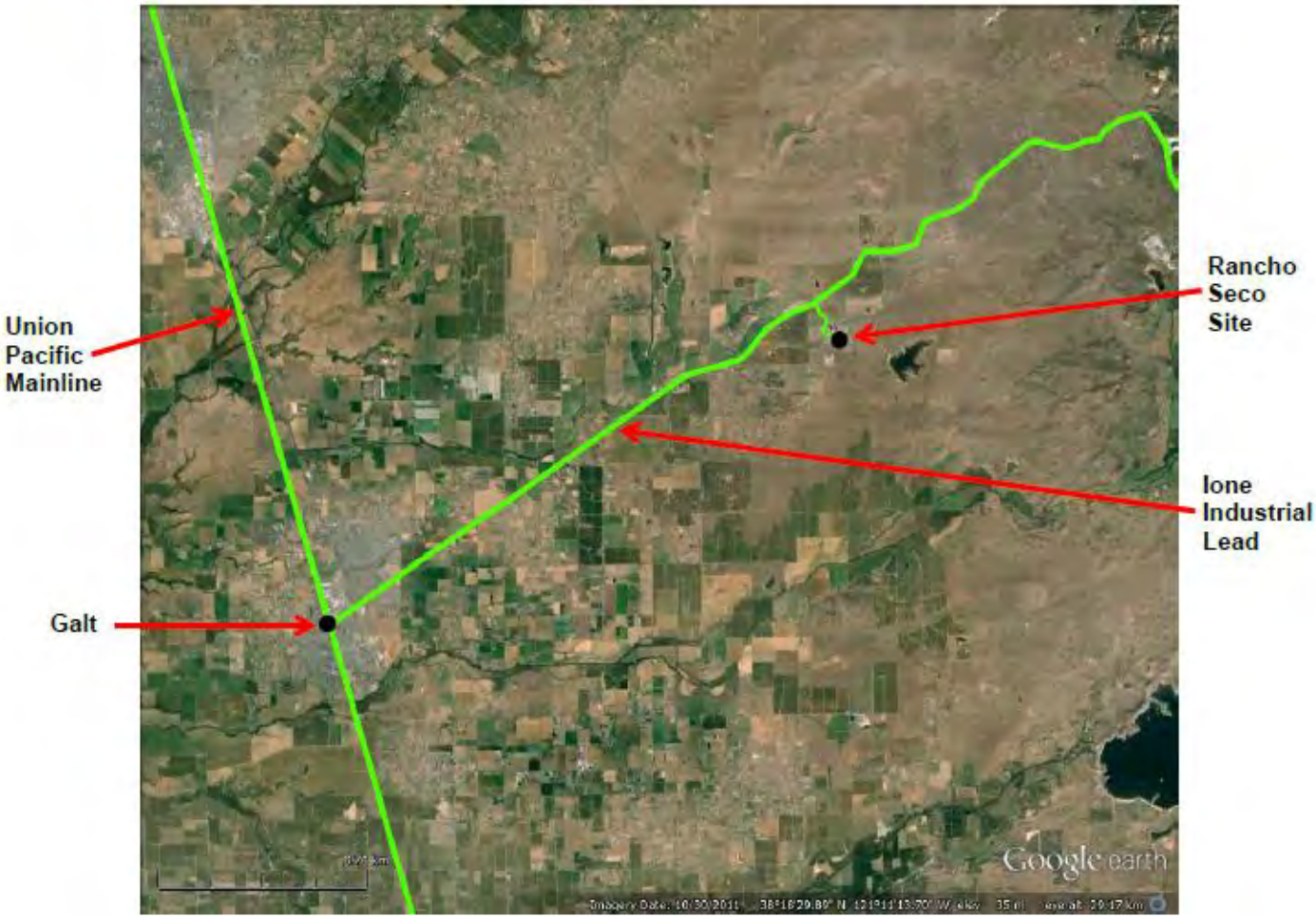
Union Pacific Mainline and Ione Industrial Lead Near Rancho Seco Site



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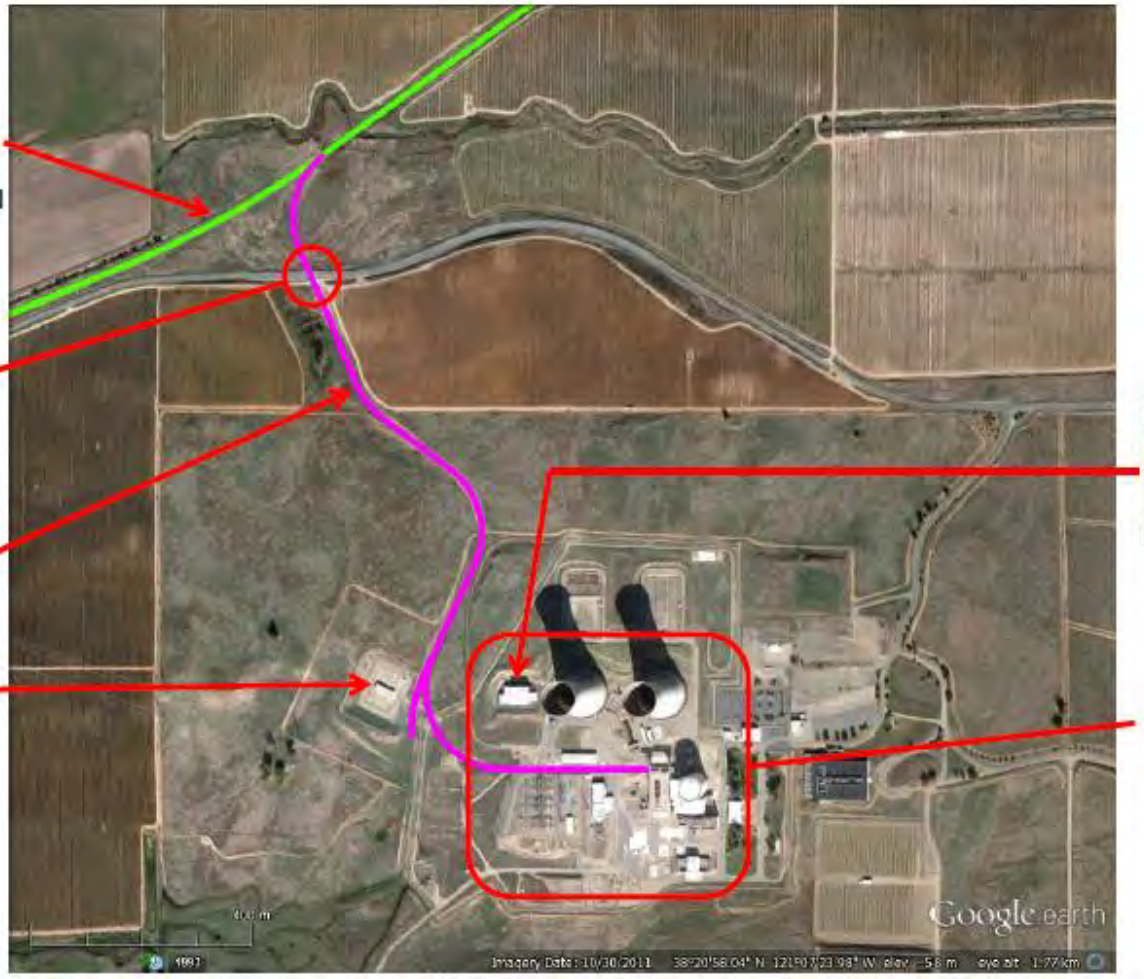
Rancho Seco Site Layout



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Rancho Seco Rail Infrastructure

Rancho Seco Rail Spur

Remnants of Rancho Seco Onsite Rail Infrastructure

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Rancho Seco Grade Crossing, Junction, and Split Rail Derailer

CA-104 and Rancho Seco Rail Spur Grade Crossing

Junction of Rancho Seco Rail Spur and Ione Industrial Lead

Split Rail Derailer on Rancho Seco Rail Spur

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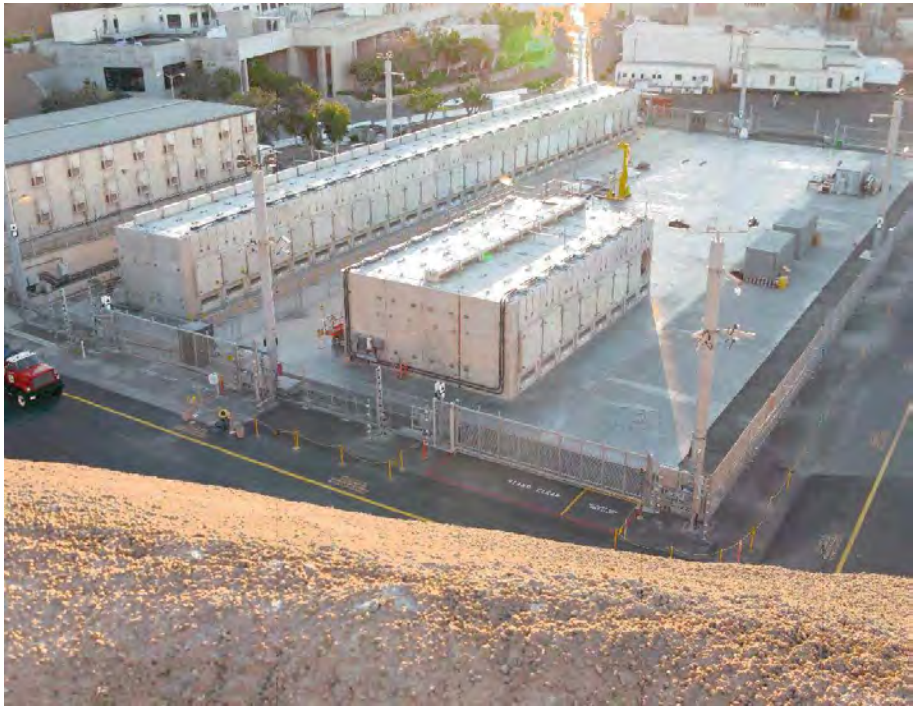
San Onofre

- **Onsite rail spur connects to BNSF mainline**
  - Spur is 0.8 miles long
  - Spur is Track Class 1
- **BNSF mainline is Track Class 4**
- **Rail spur was reactivated in 2000 to support decommissioning of San Onofre Unit 1**
- **The NFST Team has not yet visited San Onofre, so knowledge of this site is more limited than for the other western shutdown sites**



San Onofre ISFSI

San Onofre


Interstate 5
On-Site Rail Spur
San Onofre ISFSI
BNSF Railroad
San Onofre-2 and -3
405 m
1995
Google earth
Imagery Date: 11/12/2013 lat 33.371472° lon -117.556428° elev 33 m eye alt 1.74 km

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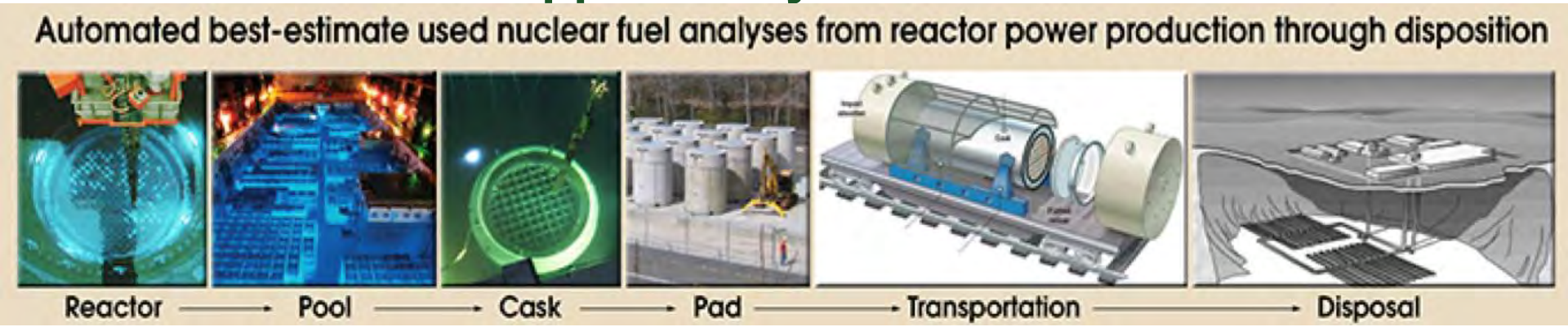
UNF-ST&DARDS is an integrating (storage, transportation, and disposal) foundational resource with broad applicability



- **A comprehensive system for analysis of the used nuclear fuel (UNF) from the time it is discharged from the reactor to the time it is disposed of in a geologic repository**
- **Unified Database (UDB)**
  - The DOE Office of Nuclear Energy resource for UNF management and disposition
- **Characterizes the input to the waste management system**
  - Assess and address issues regarding transportability of loaded casks and high burnup fuel

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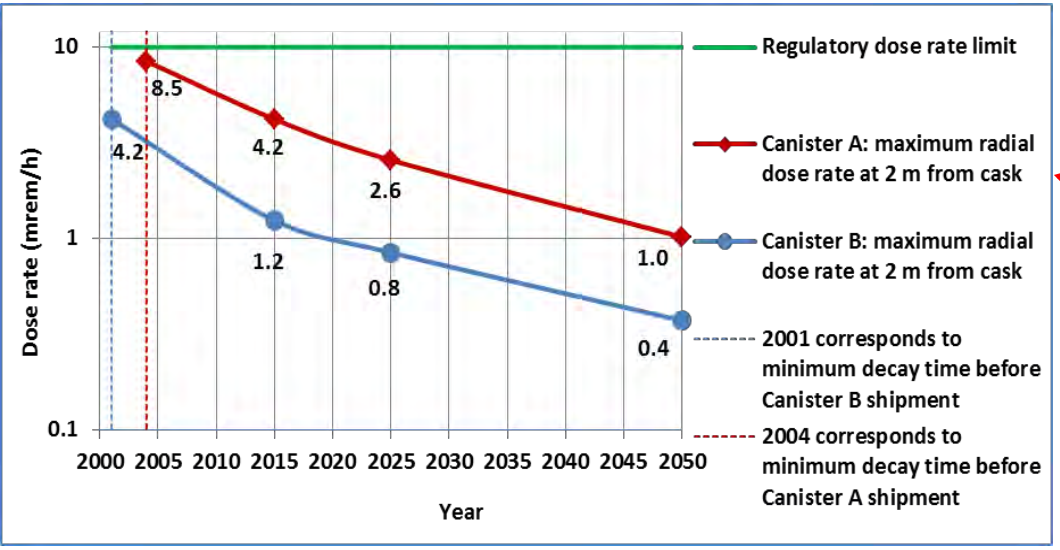
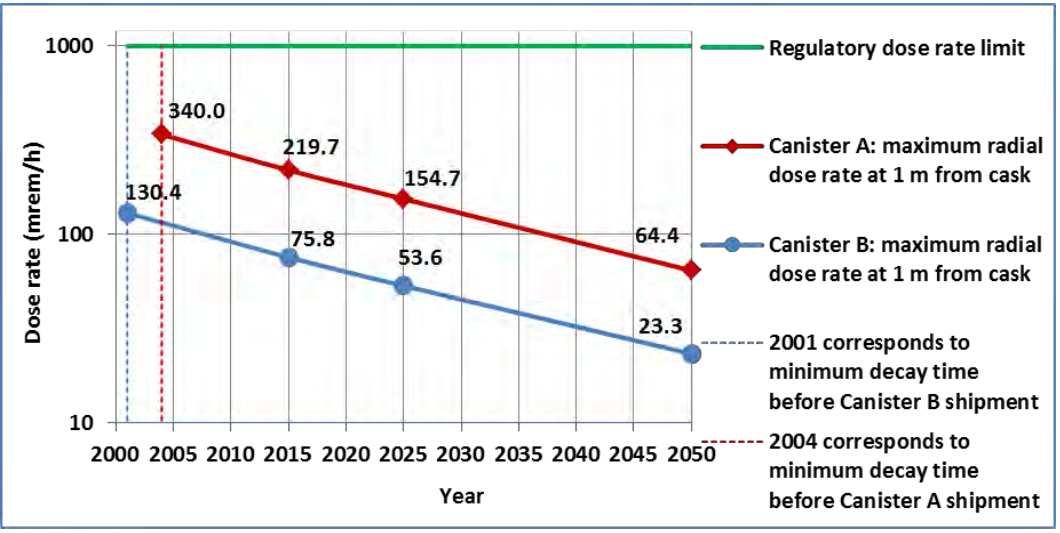
Comparison to 10 CFR 71 dose rate limits for both NCT and HAC



- Maximum Normal Conditions of Transport (NCT) dose rate at 2 m from the cask radial surface as a function of time (10 CFR 71.47(b) dose rate limit: 10 mrem/h)



- Maximum Hypothetical Accident Conditions (HAC) dose rate at 1 m from the cask radial surface as a function of time (10 CFR 71.51(a)(2) dose rate limit: 1,000 mrem/h)

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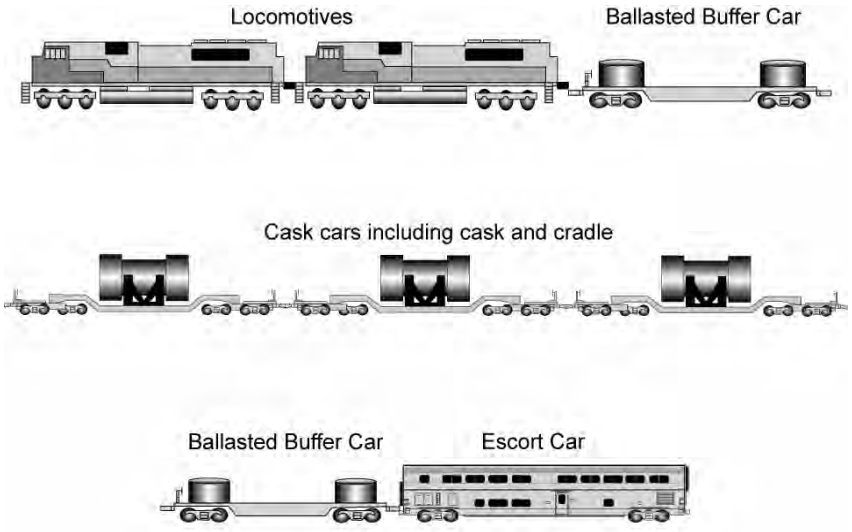
Hardware Activities are Currently Focused on Long-Lead Time Items

- **Initial planning for the procurement or leasing of casks, cask ancillary equipment, and railcar fleet**
  - Determination of certification status for each of the canister types used at the shutdown sites
  - Initial determination of cask and railcar fleets needed to de-inventory each shutdown site
- **AAR S-2043 Compliant railcar Development**



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Railcars necessary for Large-Scale Transport

- **Specialized railcars are needed to support the transportation system**
  - **Association of American Railroads (AAR) Standard S-2043 provides the performance specification for these cars**
  - **Without new railcars, the U.S. has no capability to move the very massive rail-sized casks on a large-scale basis**

- **DOE has made agreements with the Union Pacific and BNSF railroad companies, which state, "All cars supplied by the Government Shipper … will comply with AAR Construction Standards…"**

- **A consist carrying spent nuclear fuel and/or high-level waste must have buffer cars, cask cars, and an escort car.**

- **The entire consist must comply with S-2043.**

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Developing S-2043 compliant railcars is a long and detailed process

- **Development of S-2043 compliant railcars will take a minimum of 7-8 years**
  - The design process includes extensive finite element analysis modeling activities
  - The testing process is very involved
  - Initial modeling and testing may have to be repeated if the modeling and testing results do not match

	Duration (estimate)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Process	Initiate procurement								
	Design cars								
	Manufacture prototype								
	Test cars and document								
	AAR approval review								

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S-2043 Compliant Railcars will Require Special Components and Design

- The primary purpose of S-2043 is to ensure that derailments will not occur
  - To this end, the specification calls for top-of-the-line, highly reliable components
    - Electronically Controlled Pneumatic (ECP) brakes
    - On-board System Performance Monitoring, including real-time monitoring of hunting, rocking, bearing temperature, vertical acceleration, lateral acceleration, and longitudinal acceleration.
    - Trucks with Specialized Suspensions
    - Anticipate that All Components will be Commercially Available
  - Very detailed analyses must be performed prior to a prototype car being built for testing
    - Structural Analysis
    - Nonstructural Static Analysis
    - Dynamic Analysis

The testing process is comprehensive

- Testing consists of two distinct testing regimes
  - Single car testing
  - Consist testing
    - Consist testing must be done with at least one cask car, one buffer car and one escort car
- The tests are comprehensive and will take several years to complete
- Analysis results must be compared to data measurements taken during testing

Approval is two-stage process

- Conditional approval may be granted by the AAR after all required reports have been submitted
- Follow-up single-car testing is required at 50,000 miles or five years, whichever comes first
- Upon satisfactory operation of the railcar(s) for 100,000 service miles a report detailing the service must be submitted to the AAR
- Based upon this report and the proposed remediation plan for any issues identified by the report, the AAR Equipment Engineering Committee may grant full approval of the car design

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Significant Progress toward Railcar Development was Made in FY 2014

- **Issued *AAR S-2043: Use and History* report**
- **Issued *AAR S-2043 Cask Railcar Systems Requirements Document***
- **Request for Information and Sources Sought Notice (RFI/SSN) posted in FedConnect (DE-SOL-0006863)**
  - Included draft Statement of Work (SOW)
  - Requested information about companies that may be interested in responding to a Request for Proposals (RFP)
  - Requested additional information that may be helpful in developing an RFP
  - Five Responses Received

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Key NFST Transportation Linkages

NTP
180(c)
Institutional
Routing

START
Operational
Shutdown Sites
Information
UNF ST&DARDS

Casks
Railcars
Hardware
Cask Ancillary
Equipment

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