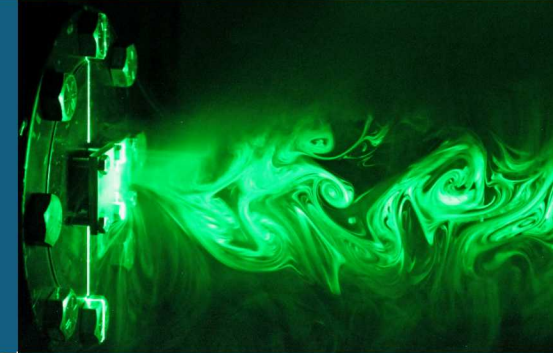


SAND2020-9178PE

Overview of Proposed Spent Nuclear Fuel Storage Canister Testing

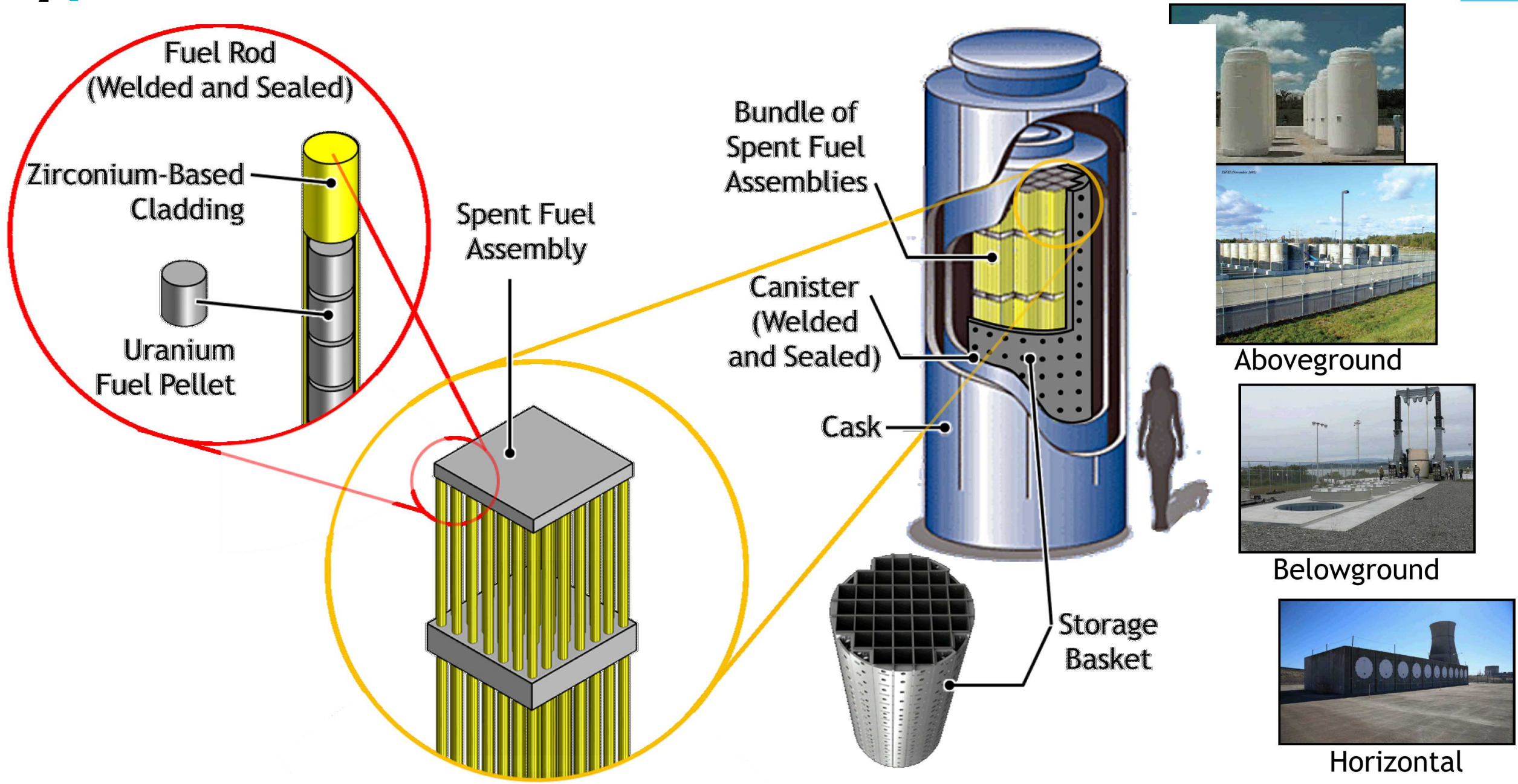


September 2020



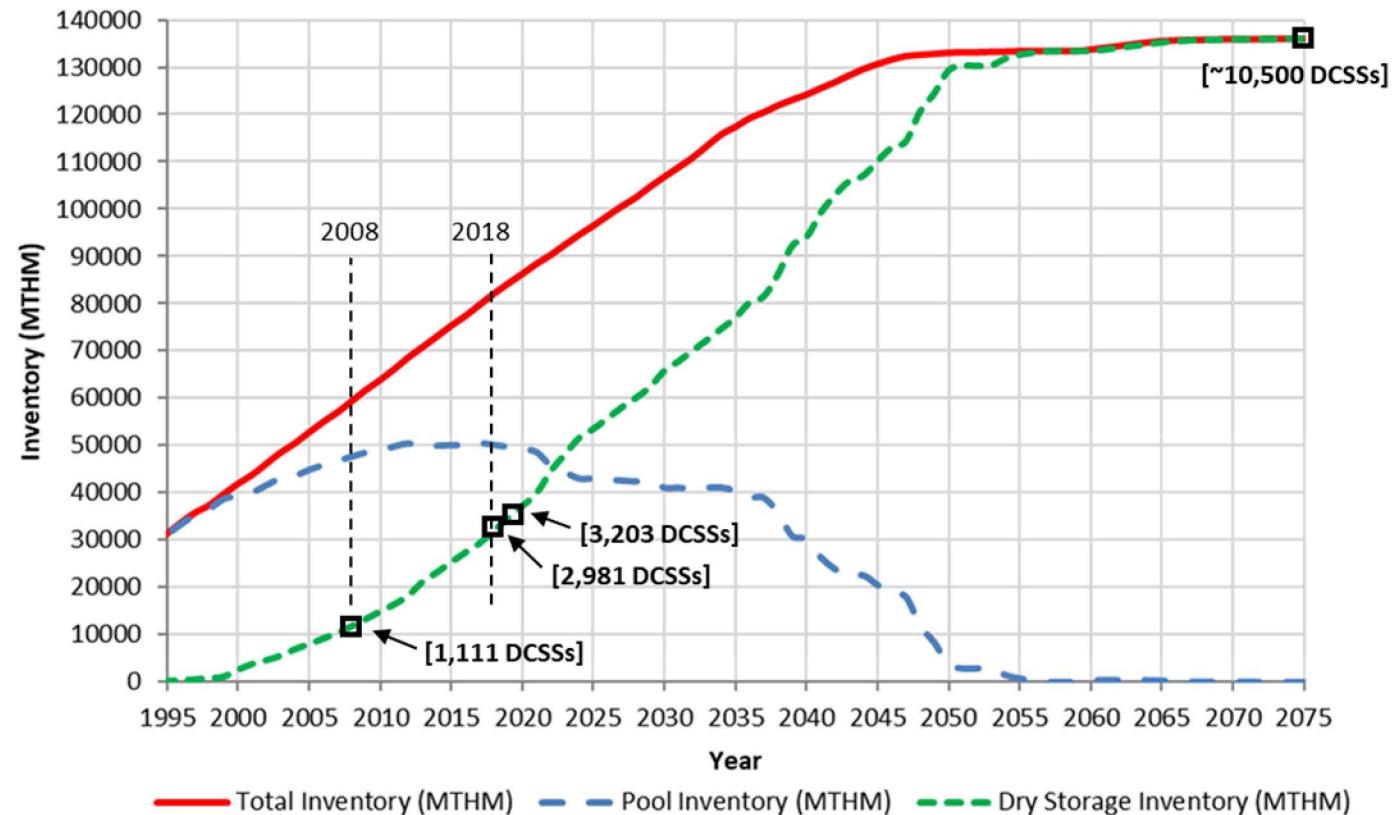
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

What Are Spent Fuel and Dry Cask Storage Systems (DCSS)?



R&D of Back End of Nuclear Fuel Cycle

- DOE NE-8 comes to Sandia to solve big problems
 - Sandia is Lead Lab for Spent Fuel and Waste Science and Technology (SFWST) campaign to perform R&D on storage, transportation, and disposal of commercial spent nuclear fuel (SNF)
 - Sandia has National Technical Director (NTD) and Control Account Manager (CAM) responsibilities for all SFWST workscope
 - R&D focus on extended storage and long-term disposability of large dual-purpose canisters (DPCs)
 - Project consistent with EHS Portfolio Prioritization Decision: “Do More Of” in Nuclear Waste Management



(Source: updated from Freeze et al. 2019, Figure 1-5)

Research Plan for 15 DOE-Owned Canisters



- 15 dry storage canisters are available for large-scale testing
 - SNL will use 8 of these canisters in testing
 - Intended for San Onofre Nuclear Generating Station (SONGS) but were never used
 - To be DOE-owned and provided to Sandia as government furnished equipment
- Canister Vendor: Orano (aka TN Americas)
- Canister Types
 - 6× 32PTH2
 - 9× 24PTH
- DCSS Type: NUHOMS Horizontal Storage Module (HSM)
- Current Location: Turtle Creek, PA

ORG	32PTH2	24PTH	Test
SONGS	3	0	Lead Canister Testing - Would occur at SONGS, but the canisters would temporarily stop at SNL for instrumentation, prior to continuing on to SONGS.
SNL	1	1	Thermal - Drying/heater testing. Can share with PNNL.
	1	1	SCC - Cut up for corrosion testing of canister and basket. Share with PNNL.
	0	1	SCC - Cut up for mitigation and repair testing, especially welds (cold spray, coatings). Share with PNNL/SRNL.
	0	0	Fillers - No additional canisters needed. Will use the baskets "harvested" from the SCC and/or Lead Canister tasks for a filler demonstration.
	0	0	Transportation - Drop Test (possible)
PNNL	0	1	Thermal - drying/water remaining. Coordinate with SNL Thermal
PNNL	0	1	Cold Spray
ORNL	0	2	Fillers
EPRI	1	2	Research
TOTAL	6	9	

Sandia Testing of 8 DOE-Owned Canisters

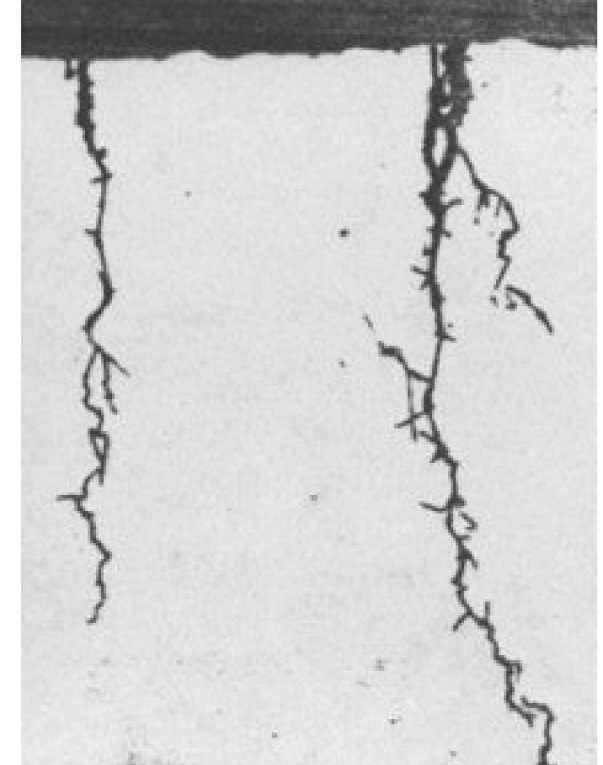
- SONGS Lead Canister Testing (3 canisters)
 - **Highlighted in this presentation**
 - Canisters will be at SNL for ~9 months for instrumentation before shipping to SONGS
- Additional Research Efforts (5 canisters)
 - Will be staged at Surtsey in Technical Area 3
 - Stress Corrosion Cracking (SCC)
 - 3 canisters will be cut up and distributed to SNL and non-SNL locations (PNNL, EPRI, NEUP Universities)
 - Working with Center 1800 on corrosion science and weld analysis
 - Thermal and drying
 - 2 canisters, testing will be coordinated with PNNL
 - Fillers
 - The purpose will be study different fillers that can be added to DPCs for moderator exclusion or as potential neutron poisons. This will support ongoing research on the direct disposal of DPCs.
 - Will use residual baskets from SCC canisters, testing will be coordinated with ORNL

SONGS Lead Canister Testing - Project Synopsis

- DOE NE-8 sponsored research seeking to measure deposition of corrosive species (chloride salts) from ambient, naturally-convective air onto spent nuclear fuel (SNF) dry canister storage systems (DCSS)
 - Information needed to inform lab-directed stress corrosion cracking (SCC) research and industry-led aging management programs (AMPs)
 - Extended long term storage of SNF at nuclear power plant (NPP) sites for foreseeable future
- Unique opportunity has arisen with potential industry partner at SONGS
 - New, *unirradiated canisters provided to DOE* as part of legal settlement
 - Prototypic canisters (5/8 in. wall SS316) and fuel basket (aluminum and SS)
 - Weight ~27.5 tons each (Valued at ~\$2M per can)
 - SNL expertise sought to design test canisters for heating, diagnostics, and surface sampling (3 cans total)
 - Electrically heated assemblies to simulate decay heat
 - Thermocouples for temperature measurement
 - Periodic surface measurement of deposits
 - SONGS in discussion with SNL, PNNL, and DOE to host test canisters
 - Providing in-kind contributions (scope and total value TBD)
 - Placement alongside prototypic systems for in-service conditions at an independent spent fuel storage installation (ISFSI) next to Pacific ocean
 - SONGS ISFSI under considerable public and political pressure to ensure long-term storage safety

Why?

- Inadequate data for surface deposits on SNF dry storage canisters
 - Driver of chloride-induced stress corrosion cracking (CISCC)
 - CISCC represents a significant portion of current SNF storage research portfolio for DOE, ISFSI operators, regulators, and industry
- Through-wall SCC would represent loss of containment*
 - Hard to detect and very difficult to repair in situ
 - Represents pathway from cladded SNF to environment
 - In violation of current regulations
- This data urgently needed to validate and guide future work
 - Extended long-term storage onsite is national reality
 - Fate of permanent, geological repository uncertain at this time
- **SNL has opportunity to be at forefront of research-defining effort with long-reaching implications**
 - Touching on industry practices, regulatory framework, and public health and safety



Typical SCC, not from SNF DCSS

Source: <https://www.imetllc.com/training-article/stress-corrosion-cracking/>

* - 10 CFR 71.43(f) A package must be designed, constructed, and prepared for shipment so that under the tests specified in § 71.71 ("Normal conditions of transport") there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging.

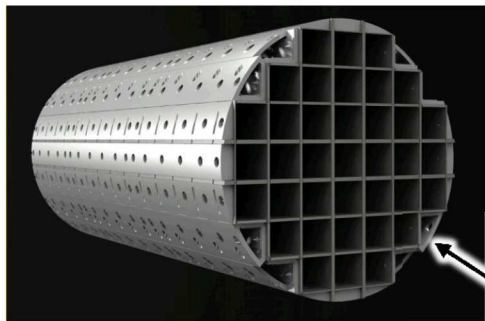
10 CFR 72.236 (j) The spent fuel storage cask must be inspected to ascertain that there are no cracks, pinholes, uncontrolled voids, or other defects that could significantly reduce its confinement effectiveness.

Who?

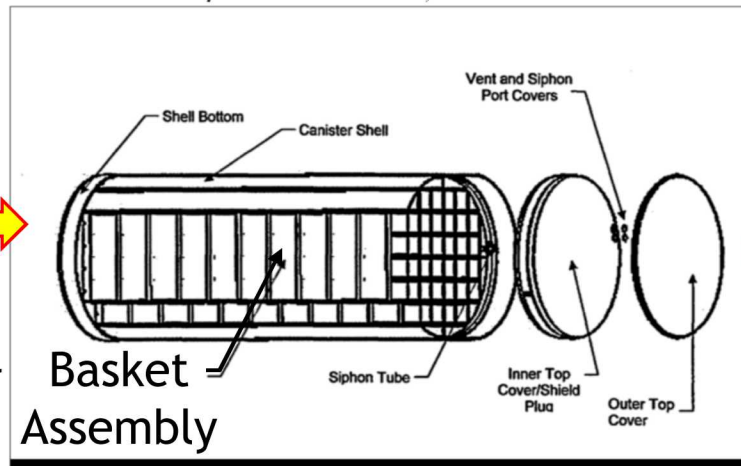
- Sponsor: DOE NE-8 (Federal Project Manager: Ned Larson)
- Canister Vendor: Orano (aka TN Americas) (Chief Technical Officer: Prakash Narayanan)
- Site Host: SONGS (Fuel Manager: Randall Granaas, ISFSI Manager: Jerry Stephenson)
- Test Team: SNL (Technical POC: Sam Durbin)
 - Senior Manager: Tito Bonano (8840)
 - S&T Lead: Sylvia Saltzstein (8845)
 - Line Manager: Geoff Freeze (8843)
 - 6630 Site Owners: Scott Sanborn (8854) and Rodney Keith (8841)
 - Material Science SMEs: Charles Bryan (8845), Rebecca Schaller (1852), Jeff Rodelas (1831)
- Modeling and Logistics Team: PNNL (PNNL Lead: Brady Hanson, Operations: Steve Ross)

What?

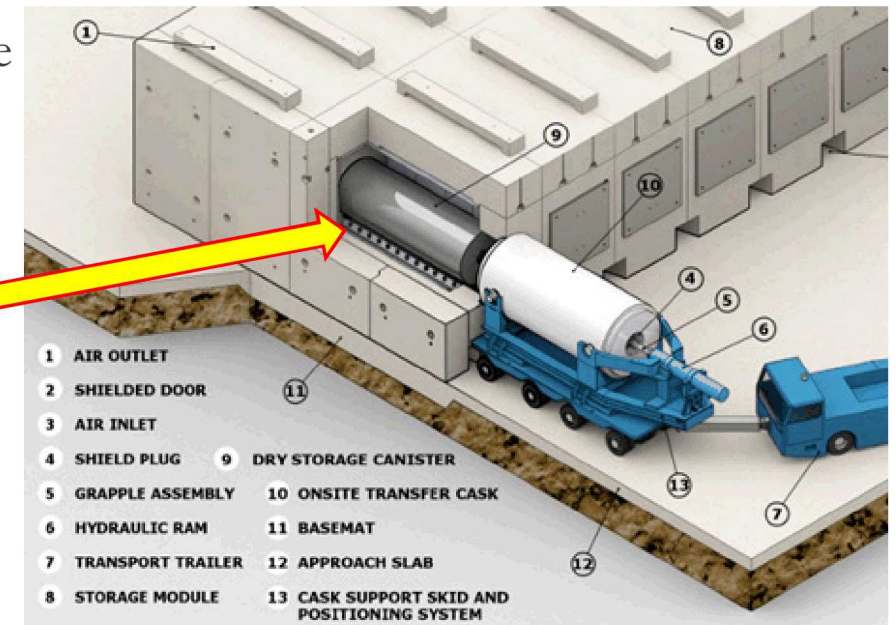
- 3× 32PTH2 spent fuel canisters
 - *New and unirradiated*
 - *Owned and provided by DOE*
 - Total weight empty 27.5 tons
- Designed to hold 32 PWR fuel assemblies
- Max. rejection heat 37.2 kW
- Electrical heaters substituted in spaces normally for SNF
- Diagnostics installed on interior and exterior
- Canister placed inside horizontal storage module (HSM)
- Deposition measurements taken periodically from canister surface



*37PTH shown

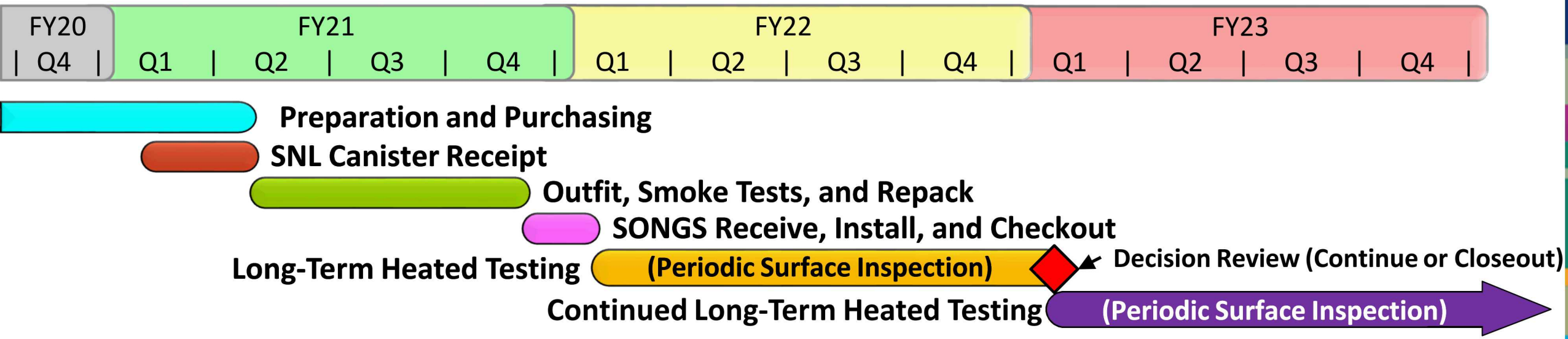


NUHOMS®-32PTH DSC

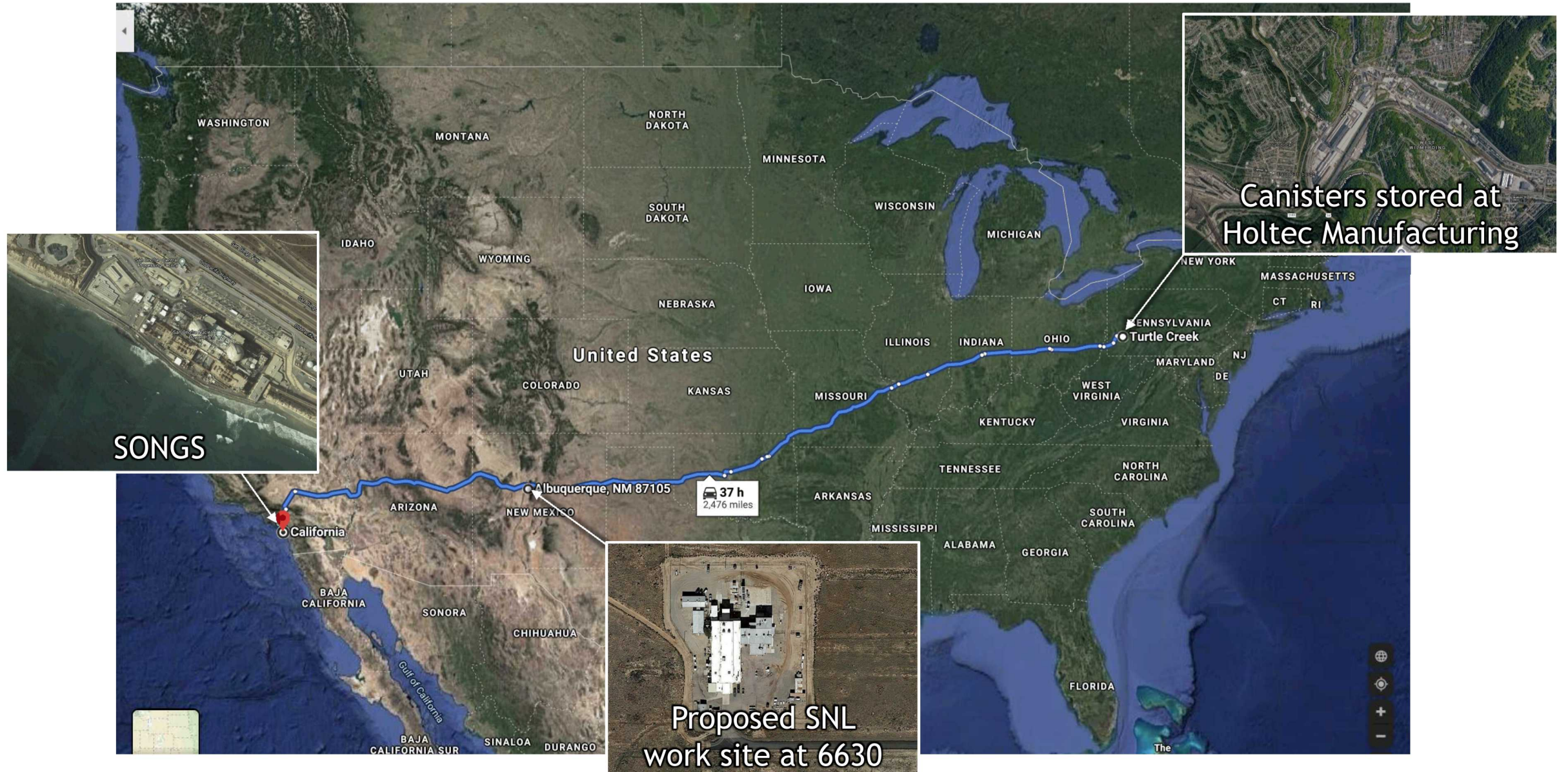


When?

- FY20 funding available for preparatory work
 - Coordination with modeling team on heater design
 - SNL site preparations and work planning
 - Logistics planning with SONGS
 - Preparation of test plan
 - Purchase of long-lead equipment
- Receipt of canisters to be determined
 - Earliest receipt estimated as *week of October 26, 2020*
- SNL onsite work expected to last 6 to 9 months after receipt
 - Loadout of heaters and instrumentation
 - Smoke tests and functionality verification
 - Lid modification for penetrations
 - Re-package and ship to SONGS



Where?



Short Term Considerations

- NDA with Orano needed to update thermal modeling, plan modifications, and receive canisters
 - Status: In process. SNL, PNNL, and Orano legal engaged
- Site planning for receipt of canisters
 - Status: In process. Initial inquiries sent to KAFB to identify POCs. Ticket entered with Facilities Minor Modifications Team (Crane logistics, millwrights, etc.). NEPA, PHS, and FMA underway. ES&H (Chuck Atwood) is included in project communications. Business team involved with Project and Financial Planning. Coordinating with Scott Sanborn (8854) to minimize impacts to ongoing operations at 6630
 - Next steps: Will reach out to government and media relations. **Planning to brief SFO**
- SONGS in-kind contributions and host duties under discussion
 - Status: In process. Meetings scheduled for every two weeks between SNL, PNNL, DOE, and SONGS
- Initial thermal modeling used to generate heater design
 - Status: In process. Feedback needed from model to determine suitability