U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

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Spent Fuel and Waste Science and Technology Storage and Transportation R&D Strategic Plan

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

EXTENDED STORAGE COLLABORATION PROGRAM

November 9, 2020

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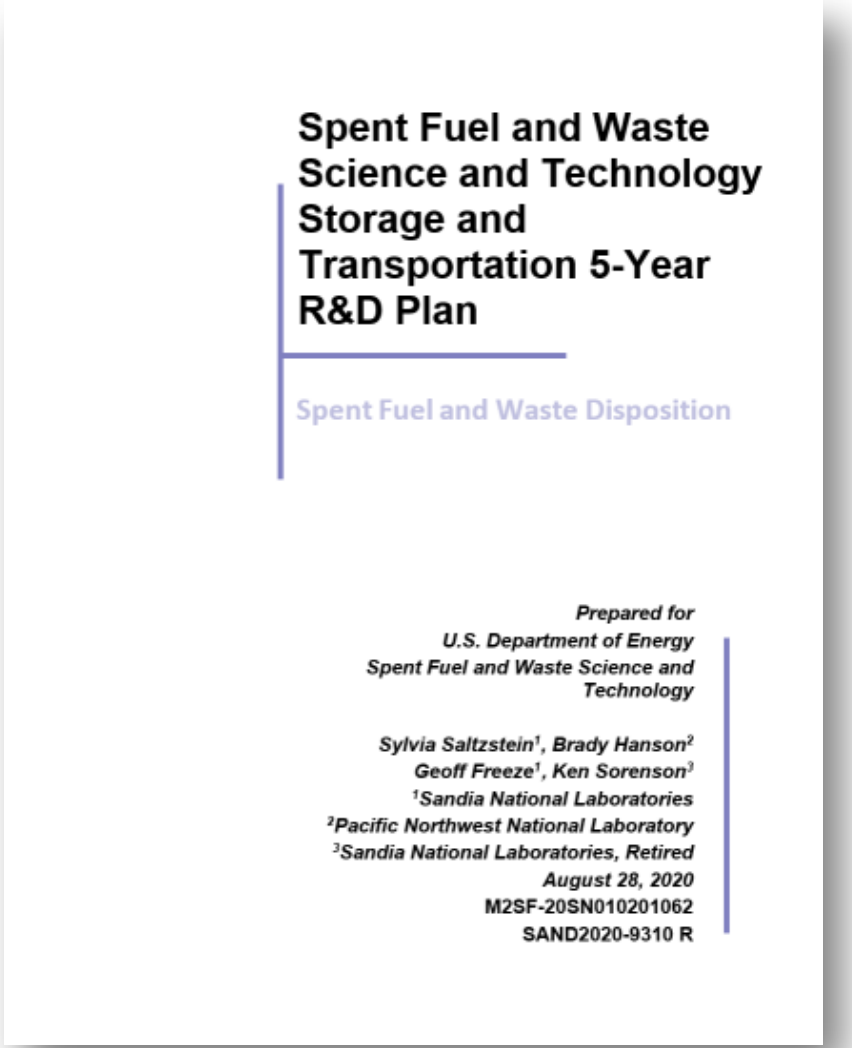
Spent Fuel and Waste Science and Technology Storage and Transportation (SWFST ST) R&D Strategic Plan

- Builds upon the Gap Analyses of 2012, 2017, and 2019
- Summarizes progress made for each gap
  1. What we have learned
  2. What we still need to learn to close this gap
  3. What it takes to consider this gap closed
  4. Proposed R&D

- One-page Strategic Plan for SWST ST
- One-page R&D Roadmap for each Gap
- These plans are subject to change based on funding appropriation, additional opportunities, or changes in direction based on what we learn from our research.


Spent Fuel and Waste Science and Technology Storage and Transportation 5-Year R&D Plan

Spent Fuel and Waste Disposition

Prepared for
U.S. Department of Energy
Spent Fuel and Waste Science and Technology

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https://www.osti.gov/biblio/1660791-spent-fuel-waste-science-technology-storage-transportation-year-plan

DOE Spent Nuclear Fuel Storage and Transportation R&D Plan Overview

Subject to change based on funding appropriation, additional opportunities, or changes in direction based on what we learn in the R&D

GAPS

Demo/Sibling Pin Testing	• Continue collecting temperature data from the Research Project Cask and plan for its transport • Develop a gap analysis for ATF and higher burnup fuels	• Continue and complete Phase 1 sibling pin testing. • Develop Phase 2 test Plan and Assessment of Gross Rupture. • Obtain Data on BWR, IFBA, and ATF cladding/fuels • Clean up hotcells and dispose of waste.	• Prepare facility and move canister	
Thermal Profiles	• Complete Round Robins • Perform Sensitivity and Uncertainty Analyses • Conduct small & large scale vertical and horizontal testing	• Continue testing/analyses on canistered and bare fuel systems in horizontal and vertical orientations, emplacement in transportation cask, leaking canisters, plugged vents, wind effects, and time to boil.		Close Gap
Stress Profiles	• Design, Fabricate, and Test 8-Axle Railcar • Complete 30cm drop test analysis • Determine pinch loads and seismic loads adding simulated irradiated materials	• Determine the magnitude of pinch loads via drop tests in the horizontal and Vertical Orientations adding simulated irradiated materials.	• Build cumulative effects models • Collaborate with the Republic of Korea on their MMTT program	
Welded Canister-Atmospheric Corrosion	• Continue corrosion initiation and crack growth rate tests • Continue brine stability testing and collect additional dust samples • Refine, improve, and validate deposition models	• Obtain residual stress measurements on different canisters • Perform small scale and larger-scale testing to provide data for deposition modeling	• Conduct a full-scale canister deposition demonstration at various heat loads to provide data on deposition and brine stability • Examine multiple repair and mitigation techniques to extend the lifetime of a canister	
Drying	• Design and perform lab-scale tests with well-defined conditions to improve sampling and analysis techniques • Collect and analyze in-service gas samples	• Design and perform larger-scale tests using heater assemblies to quantify residual water as a function of drying parameters	• Design and perform a full-scale test using heater assemblies • Perform a consequence analysis	Close Gap
Canister Failure Consequence	• Grow through wall stress corrosion cracks for testing • Incorporate particle size distribution of SNF released in different scenarios • Test and model flow through more realistic microchannels and aerosols. • Analyze particulates captured in filters used during the drying process of failed fuel.	• Test viability of canister repair and mitigation techniques under realistic pressure and canister conditions. • Measure aerosol release and depletion in realistic DSC environments		Close Gap

Priority 1 Gap: Thermal Profiles

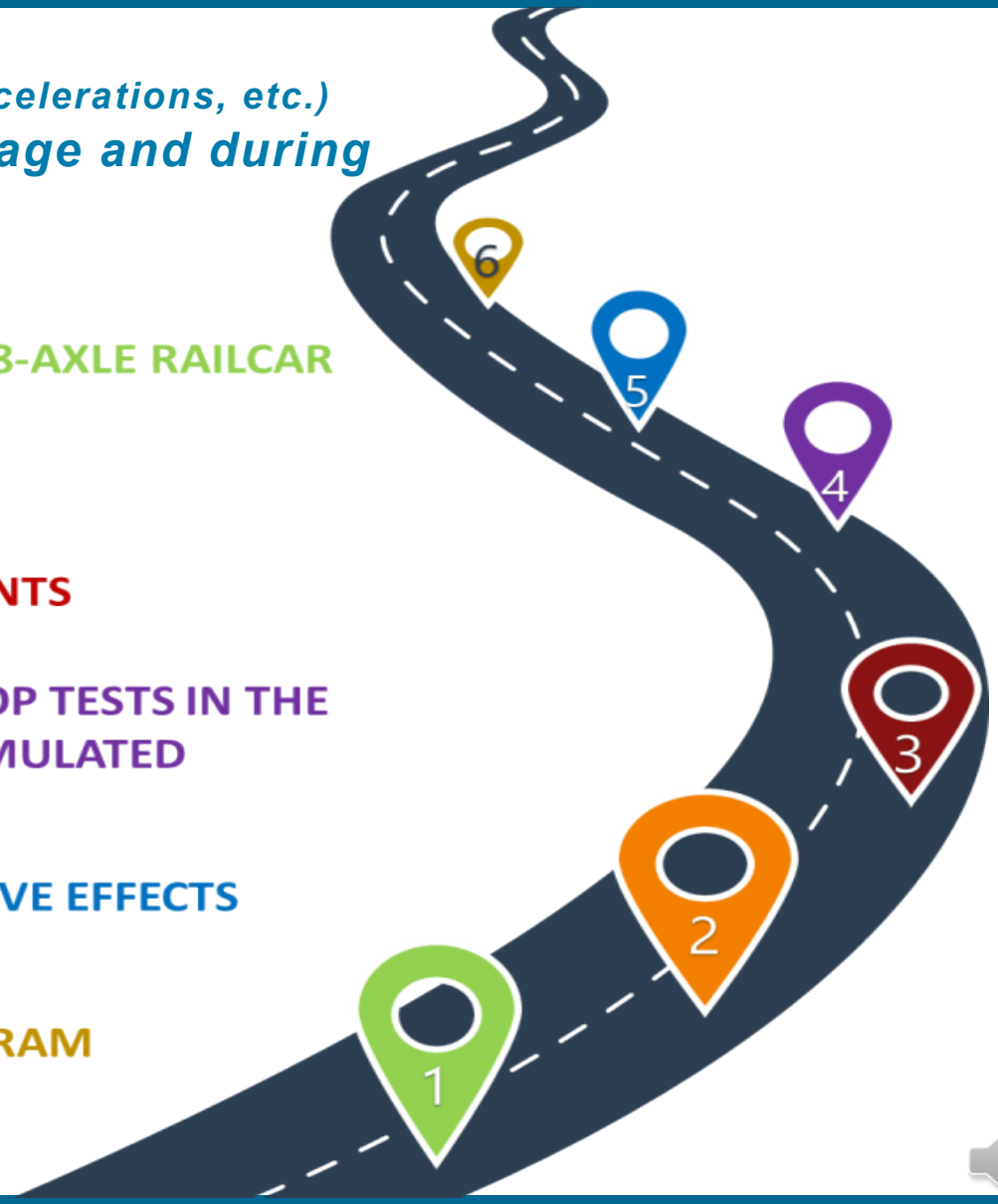
Objective: Identify the range of temperatures to which each structure, system, and component will be subjected.

1. PERFORM MODELING SENSITIVITY ANALYSES TO DETERMINE THE EFFECT OF CANISTER ATMOSPHERE TO DETERMINE IF CANISTER SURFACE TEMPERATURES CAN BE USED TO IDENTIFY LEAKING CANISTERS
2. DEVELOP AND PERFORM A DETAILED UNCERTAINTY ANALYSIS
3. BUILD, TEST, AND MODEL LARGER SCALE VERTICAL AND HORIZONTAL DRY CASK SIMULATORS
4. ESTIMATE TEMPERATURES ONCE A CANISTER IS PLACED IN A TRANSPORTATION CASK, WHEN VENTS ARE BLOCKED, WIND EFFECTS, AND OTHER ISFSI PHENOMENA.
5. IMPROVE TIME TO BOIL CALCULATIONS

Priority 1 Gap: Stress Profiles

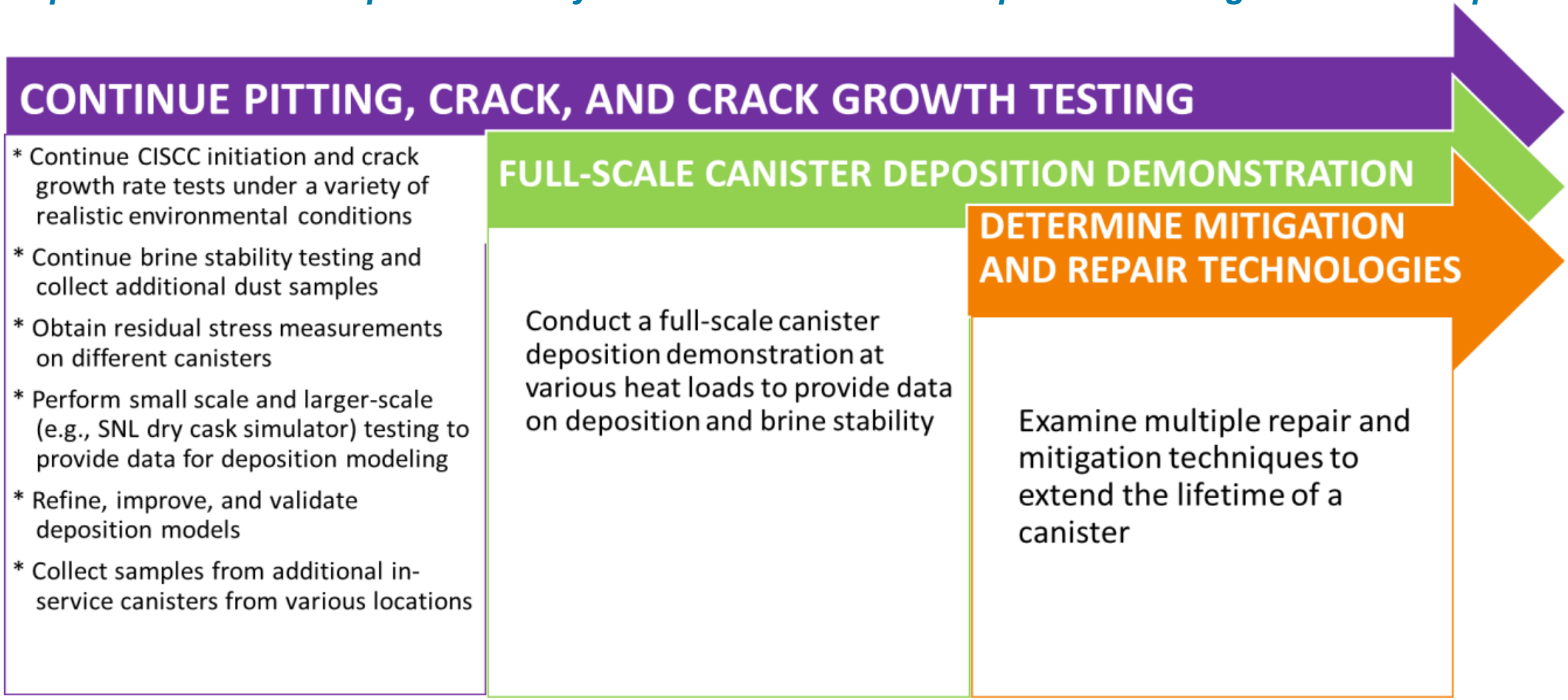
***Objective: Quantify the external loads** (forces, strains, accelerations, etc.) that SSCs might be subjected to during extended storage and during normal conditions of transport.*

1. CONTINUE DESIGN, FABRICATION, AND TESTING OF AN 8-AXLE RAILCAR
2. COMPLETE ANALYSIS OF THE 30 CM DROP TESTS
3. DETERMINE LOADS DURING DESIGN BASIS SEISMIC EVENTS
4. DETERMINE THE MAGNITUDE OF PINCH LOADS VIA DROP TESTS IN THE HORIZONTAL AND VERTICAL ORIENTATIONS ADDING SIMULATED IRRADIATED MATERIALS.
5. DEVELOP THE FRAMEWORK FOR AND BUILD CUMULATIVE EFFECTS MODELS
6. COLLABORATE WITH THE SOUTH KOREAN MMTT PROGRAM



Priority 1 Gap: Welded Canister – Atmospheric Corrosion

Objective: To acquire data to inform decisions on the timing for inspections, the impacts on a consequence analysis and the need for repair and mitigation techniques.



Priority 1 Gap: Demo Project & Sibling Pin Testing

Objective: Provide data on the performance of high burnup SNF during storage

1. CONTINUE COLLECTING TEMPERATURE DATA FROM THE RESEARCH PROJECT CASK AND PLAN FOR ITS TRANSPORT
2. CONTINUE AND COMPLETE PHASE 1 SIBLING PIN TESTING. DEVELOP PHASE 2 TEST PLAN AND ASSESSMENT OF GROSS RUPTURE.
3. DEVELOP A GAP ANALYSIS FOR ATF AND HIGHER BURNUP FUELS
4. OBTAIN DATA ON BWR, IFBA, AND ATF CLADDING/FUELS

The Demo canister will then be brought to a national lab to test its high burnup rods.

Priority 2 Gap: Drying Issues

Objective: Determine amount of residual water in a cask after drying and understand the risk of fuel oxidation or hydrogen buildup.

1. DESIGN AND PERFORM LAB-SCALE TESTS THAT HAVE WELL-DEFINED CONDITIONS TO IMPROVE SAMPLING AND ANALYSIS TECHNIQUES

2. DESIGN AND PERFORM LARGER-SCALE TESTS USING HEATER ASSEMBLIES TO QUANTIFY RESIDUAL WATER AS A FUNCTION OF DRYING PARAMETERS

3. DESIGN AND PERFORM A FULL-SCALE TEST USING HEATER ASSEMBLIES

4. COLLECT AND ANALYZE GAS SAMPLES FROM ACTUAL DCSS AFTER DRYING AND HELIUM BACKFILL.

5. PERFORM A DETAILED CONSEQUENCE ANALYSIS TO DETERMINE EFFECTS, IF ANY, ON SSCS CAUSED BY RESIDUAL WATER.

Priority 2 Gap: Consequence Assessment of Canister Failure

Objective: Perform a realistic risk assessment of the radiological consequence of a potential breach of confinement

1. CONTINUE TESTING AND MODELING OF FLOW AND TRANSMISSION THROUGH ENGINEERED MICROCHANNELS
2. INCORPORATE PARTICLE SIZE DISTRIBUTION OF SNF RELEASED IN DIFFERENT SCENARIOS TO THE TESTING AND MODELING
3. ANALYZE PARTICULATES CAPTURED IN FILTERS USED DURING THE DRYING PROCESS OF CANISTERS CONTAINING FAILED FUEL TO APPLY TO TESTING AND MODELING
4. GROW THROUGH WALL STRESS CORROSION CRACKS FOR USE IN TESTING
5. TEST VIABILITY OF CANISTER REPAIR AND MITIGATION TECHNIQUES UNDER REALISTIC PRESSURE AND CANISTER CONDITIONS.
6. MEASURE AEROSOL RELEASE AND DEPLETION IN ENVIRONMENTS CHARACTERISTIC OF DRY STORAGE

Gaps are not Stovepipes. The teams talk to each other and adjust based on each other's learnings. EPRI ESCP facilitates this collaboration.

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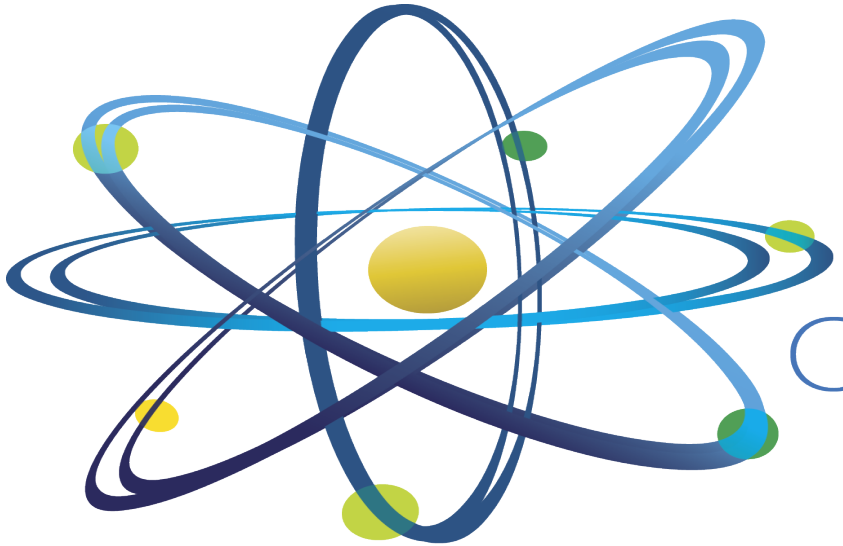

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