

CEP Discussion: **AREVA's SONGS-Specific Used Fuel Solution**



AREVA TN

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AREVA TN



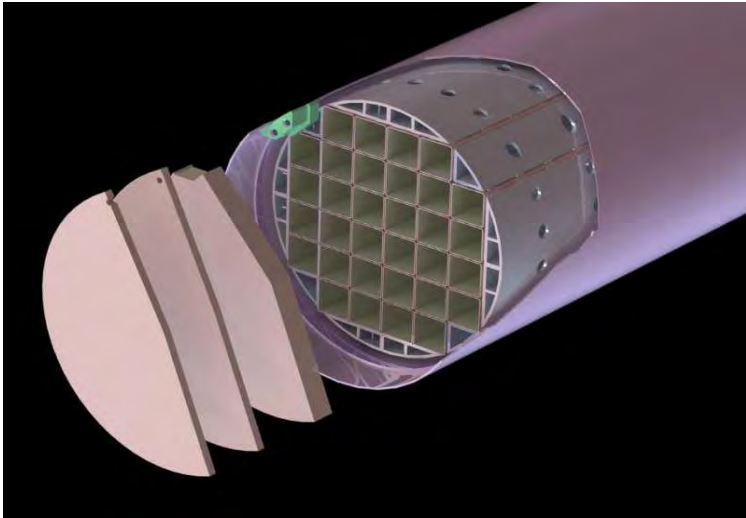
AREVA's SONGS-Specific Solution

Topical Outline



- 1. Overview of Cask/Canister System Design and Implementation**
- 2. Defense in Depth, Maintenance & Surveillance Requirements**
- 3. Anticipated Aging Management Plan**
- 4. Mitigation of Degraded Canister**

1. Overview of Cask & Storage System Design and Implementation



Dry Shielded Canister

- ▶ The primary criticality control and storage container for the used fuel assemblies
- ▶ Shell designed for extremely long lifetime
- ▶ Ability to “can” assemblies in retrievable cans (NRC license submittal in progress)



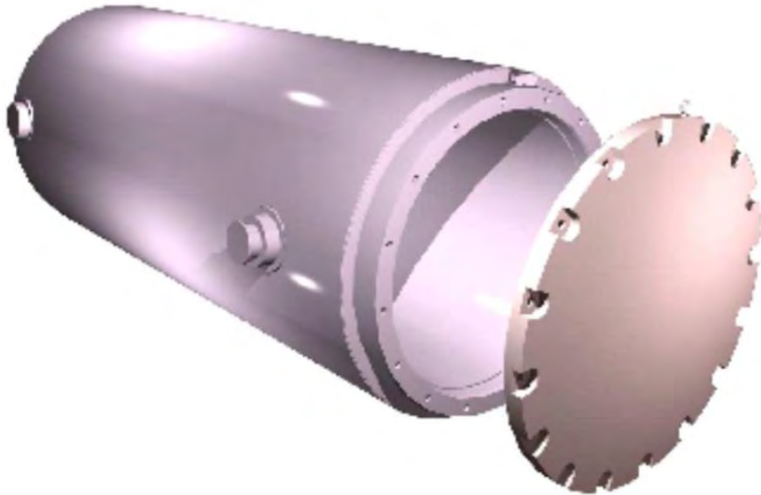
High Seismic Horizontal Storage Module

- ▶ Passively removes heat from canister
- ▶ Protects canister against external hazards
- ▶ Protects canister from the environment
- ▶ Provides heavy duty biological shielding

>> Robust Design is Engineered for Long-Term Storage

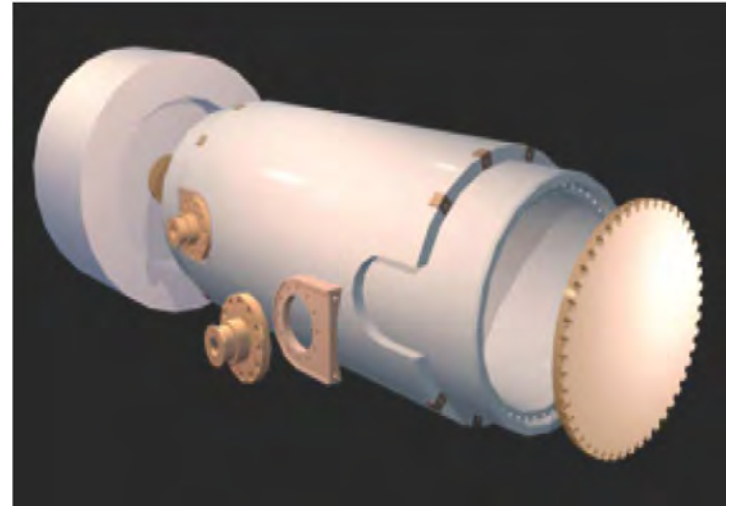
1. Overview of Cask & Storage System

Design and Implementation



Transfer Cask

- ▶ Assures safe loading and transfer of the canister from the Spent Fuel Pool to the storage module
- ▶ Provides biological shielding during transfer
- ▶ Loaded canister is always in the transfer cask during handling



Transportation Cask

- ▶ Transports fuel safely away from the site
- ▶ In fabrication now; ready to deploy in 2016
- ▶ Only cask licensed to transport canisters loaded with high burn-up fuel in the U.S.

>> NUHOMS® Systems are Licensed Today to Transport SONGS Fuel Off-Site

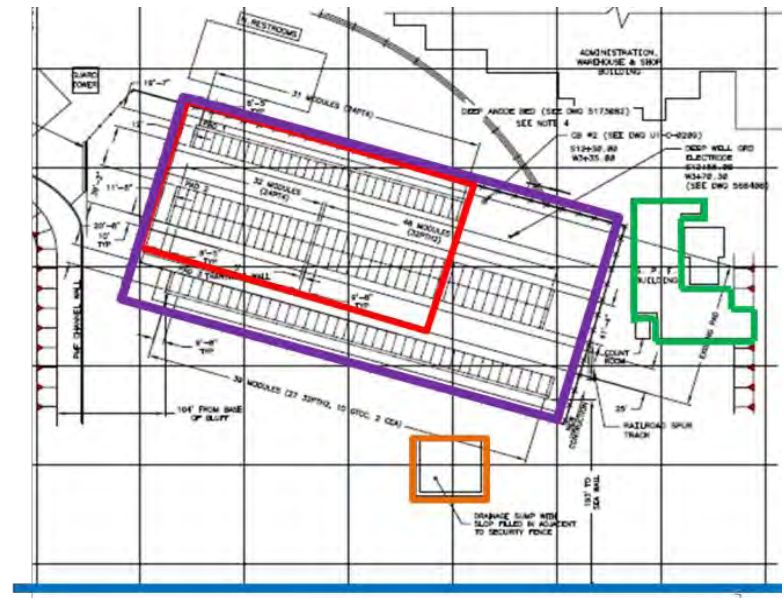
1. Overview of Cask and Storage System Design and Implementation

- ▶ Requires expansion of existing ISFSI pad
- ▶ Horizontal storage requires shallow excavation
- ▶ Low schedule risk for meeting spent fuel pool offload dates

One Phase:

Expand existing ISFSI structure to accommodate new storage modules

Existing ISFSI PAD
Expanded ISFSI PAD
Drainage Sump
Security Building
Sea Wall



- ▶ Implements technology already in use at SONGS
- ▶ Final appearance can be readily enhanced during final site grading

➤➤ **NUHOMS® Implementation Assures Path of Greatest Certainty to Early Spent Fuel Pool Off-Load**

2. Defense in Depth Layers of Protection

▶ Key Safety Functions

Heat Removal

- ▶ Ensure fuel/cladding stays intact and in stable temperature range

Confinement

- ▶ Protect public health and safety by keeping radioactive material out of the biosphere

▶ Defense in Depth Components

- ◆ Fuel Assemblies (pellets and cladding)
- ◆ Dry Shielded Canister
- ◆ Horizontal Storage Module
- ◆ Robust Learning Aging Management Program (LAMP)
 - Inspection/Monitoring
 - Mitigation/Repair
 - Isolation/Replacement

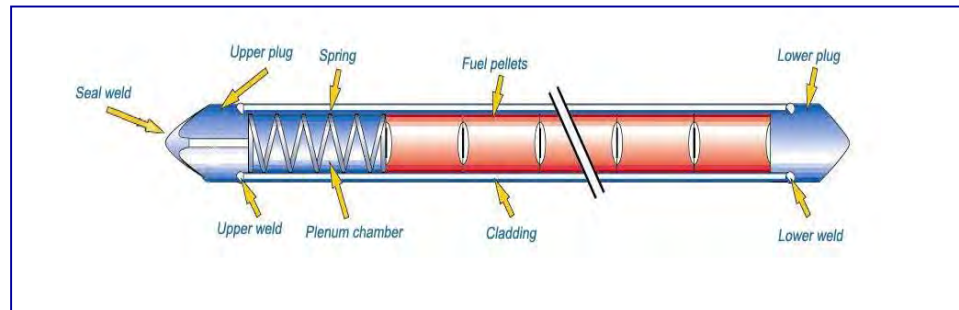
➤➤ **Protecting the Fuel is Our Number One Safety Priority**

2. Defense in Depth: Fuel Assembly Integrity



▶ Fuel Pellets (UO_2)

- ◆ Hard ceramic matrix that locks in and immobilizes 99.9%+ of radioactive materials
- ◆ Keep temperature within stable limits to keep radioactive materials trapped inside the pellets



▶ Fuel Rod Cladding (Zirconium metal alloy)

- ◆ Added layer of protection for the fuel pellets
- ◆ Contain radioactive gases generated in the fuel
- ◆ Keep temperature within stable limits to keep cladding intact

➤➤ **First Line of Defense to Contain the Radioactive Inventory**

2. Defense in Depth – Heat Removal: Canister and HSM Design



▶ Dry Shielded Canister

- ◆ Canister cools fuel passively through internal conduction to shell surface
- ◆ Helium leak would have minimal impact on heat removal capabilities

▶ Horizontal Storage Module

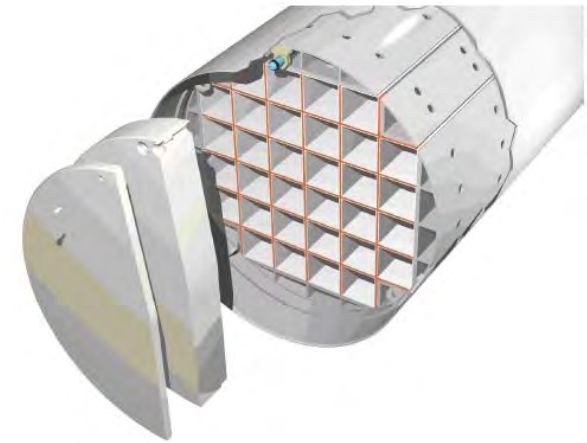
- ◆ Passive cooling maintained even if lower vents blocked by flood/debris
- ◆ Expedient debris and mud removal from airflow paths
- ◆ Easily accessible for visual inspection of airflow paths

➤➤ Above Ground System Provides Robust Heat Removal Capabilities

2. Defense in Depth – Confinement: **Canister Design**

▶ **Dry Shielded Canister**

- ◆ Confinement barrier for radioactive gases escaping the fuel assemblies
- ◆ Corrosion-resistant stainless steel shell designed for 100 year + lifetime with LAMP
- ◆ Low helium back-fill pressure
- ◆ Loaded canister is always in the transfer cask during handling
- ◆ Double welded lid safeguards confinement integrity



▶ **Inspections During Fabrication**

- ◆ Every canister is tested under the most robust guidelines as dictated by Section III, Subsection NB of the ASME code and ANSI N 14.5
- ◆ Mechanical testing for yield strength, ultimate strength and elongation of each component
- ◆ Completed fabrication welds are 100% visually and 100% radiographically inspected

➤➤ **Engineered and Fabricated with Highest Level of Standards**

2. Defense in Depth – Confinement: Horizontal Storage Module Design

▶ Horizontal Storage Module

- ◆ 4 foot thick steel reinforced concrete roof
- ◆ Dose reduced to levels indistinguishable from natural background radiation at ISFSI fence

▶ Licensed to withstand all of SONGS Site-Specific External Hazards

- ◆ **Earthquake**: 1.5g horizontal / 1.0g vertical / acceleration specification makes NUHOMS® the highest seismically qualified dry storage system in the world
- ◆ **Tsunami/Flood**: qualified for a flood height more than the SONGS site design basis flood height
- ◆ **Tornado**: can withstand impact of tornado accelerated objects
- ◆ **Aircraft Impact**: no release of radioactive material in case of aircraft impact and above ground system not susceptible to jet fuel fires



➤➤ **Robust Storage Module Engineered to Perform Through Hazards**

3. Learning Aging Management Program (LAMP) **3 Pillars**

▶ Adaptive System – 3 Pillars

- ◆ Inspection/Monitoring
- ◆ Mitigation/Repair
- ◆ Isolation/Replacement

▶ Periodic Inspections – Data Collection

- ◆ Initiated at license renewal; timed to occur well before degradation can progress
- ◆ Subsequent 5 year inspection intervals are spaced to detect any degradation mechanism

▶ Potential additional inspection

- ◆ LAMP includes “toll gate” feature at five year intervals, which evaluates latest research and industry experience of dry storage aging mechanisms and inspection methods and results
- ◆ Correspondingly appropriate changes to LAMP will be implemented

➤➤ **LAMP is a Further Line of Defense for Long Term Storage**

3. Aging Management Plan: **Inspection Capabilities**

▶ Inspections

- ◆ Capability for inspection of 100% of canister surface

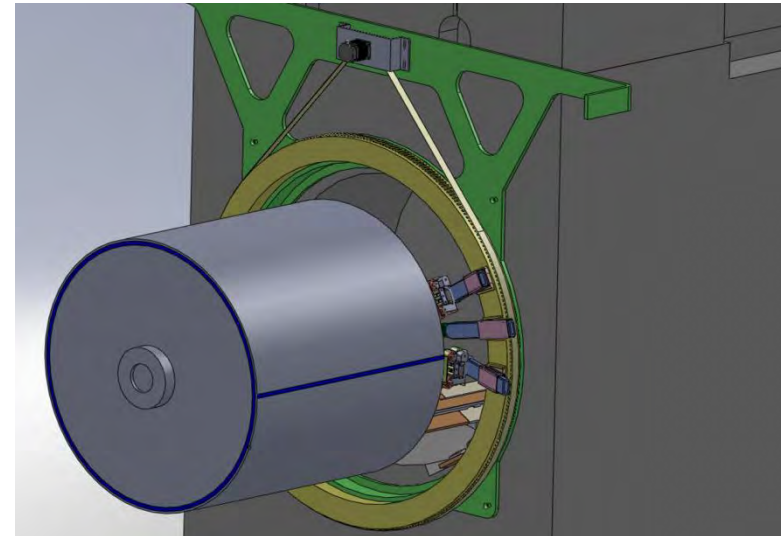
▶ Non-Destructive Examination (NDE) Tools

- ◆ Exam tools ready for field deployment in 2016 -- 7 years ahead of need for SONGS license renewal
- ◆ Current standard is enhanced Visual Inspection (VT) using high resolution video cameras; can use other techniques if needed

▶ Above ground system allows for:

- ◆ Simple retrieval for inspection and shipment
- ◆ Accessibility in case of remediation (cleaning, repair)

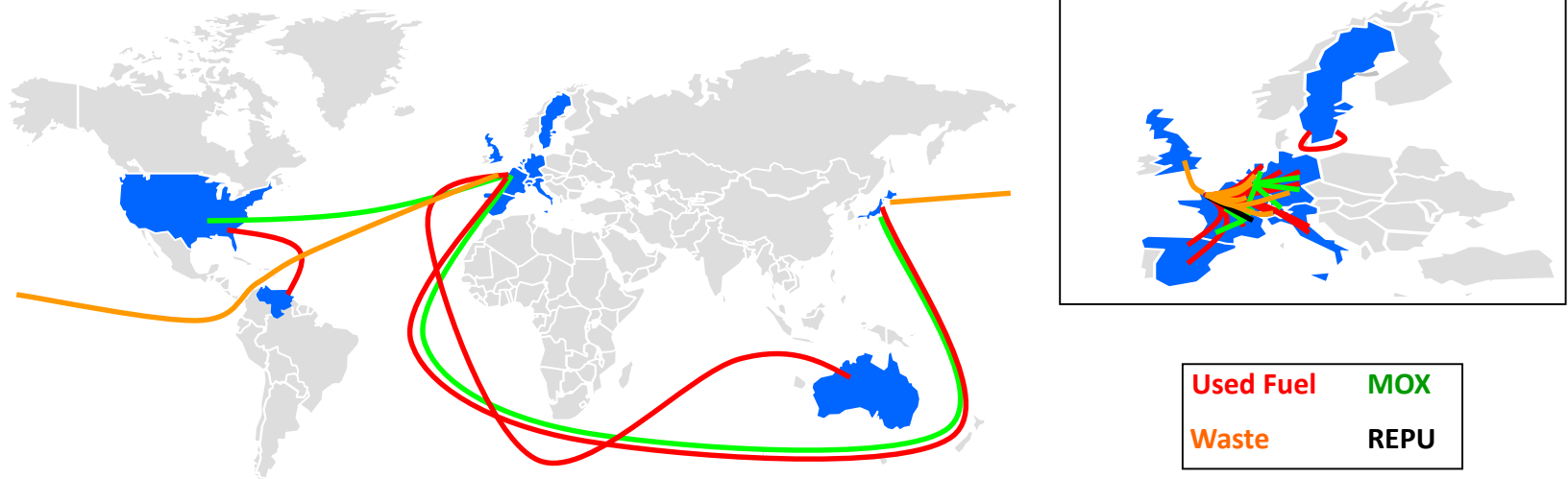
➤➤ **NUHOMS® System Provides Easy Access for Inspection**



3. Aging Management Plan: **Research and Licensing**

- ▶ **The NRC issued the initial licenses for components for 20 years, and will reissue them in up to 40-year increments with “toll gates”**
 - ◆ AREVA TN currently submitting license renewals at other sites
 - ▶ **AREVA has 5 years of experience in research and development of LAMP**
 - ◆ SONGS NUHOMS® system will have the benefit of standardized NUHOMS® System LAMP experience (17 sites, 381 DSCs and 3000+ “canister years”)
 - ▶ **Long term NRC High Burn-up Fuel (HBF) licensing coordinated with DOE/EPRI Research**
 - ◆ AREVA (TN-32) plays a central role in the Department of Energy’s HBF storage research and demonstration program
 - ◆ AREVA TN plays critical role in study concerning licensing analysis
 - ◆ AREVA’s global research and engineering resources augments DOE/EPRI Research
- » AREVA TN is at the Forefront of High Burn-up Fuel Research and LAMP Development**

3. Aging Management Plan: Long-Term Solutions



- ▶ AREVA TN has a fully-licensed solution for off-site transportation today
- ▶ Since 1966, AREVA TN has transported more than 75,000 spent nuclear fuel assemblies worldwide, including 15,000 high burn-up fuel assemblies
 - ◆ No release of radioactive material ever
 - ◆ No damage to fuel during transport

➤➤ AREVA TN has the Most Experience in Transporting Used Fuel...including High Burn-up Fuel

4. Mitigation of Degraded Canister **Repair/Replacement**

▶ Canister Repair

- ◆ Sufficient time exists for remediation action due to extremely slow progress of degradation mechanisms
- ◆ If an indication is detected by LAMP on a canister it can be repaired by well established, nuclear industry best practices and techniques
- ◆ Through-wall crack poses no threat to health and safety of the public

▶ Canister Replacement

- ◆ Utilize pre-staged overpack module with canister sleeve to isolate a canister needing replacement
- ◆ Overpack sleeve is sealed and monitored
- ◆ Transportation cask is used to move canister off-site

>> No Impact to Public Health and Safety

Conclusion



▶ Long-term public health and safety is assured through “Defense in Depth” protection:

- ◆ Fuel rod in the assembly captures 99.9%+ of radioactive material by design
- ◆ Canister is designed to remove heat and confine any radioactive gases
- ◆ Storage Module is designed to remove heat and protect canister from external hazards
- ◆ Adaptive and Conservative Learning Aging Management Program ensures long-term integrity of the system
 - Inspection/Monitoring
 - Mitigation/Repair
 - Isolation/Replacement

▶ AREVA TN has more than 50 years of experience in safely managing used nuclear fuel

>> SONGS Can Rely on AREVA TN as a Strong, Long-Term Partner