

High Burnup Dry Storage Cask Research and Development Project

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Purpose of the Project

- A project for High Burnup Dry Storage Cask Research and Development Project (also referred to as the “High Burnup Dry Storage Research Project” (HDRP)) was assembled by the industry to address long-term dry storage of high burnup fuel
- The HDRP is sponsored by the U.S. Department of Energy - Office of Nuclear Energy (DOE-NE) and the Electric Power Research Institute (EPRI).

Key Players

- **Project Team**
 - Department of Energy – Office of Nuclear Energy
 - EPRI
 - Areva Federal Services
 - Areva – TN
 - Dominion
- **Critical Support**
 - Areva, Inc.
 - Westinghouse
 - NAC International
 - Industry Review Team
 - EPRI Chartered, chaired by Xcel Energy, EPRI membership participation
 - NEI
 - National Laboratories

What are the industry needs?

- Due to continued delays in the introduction of reprocessing or permanent disposal in most countries that operate nuclear power plants, the need for longer-term storage of SNF is increasing worldwide
- High burnup license renewal beyond 20 years
- Need confirmatory data to back up research and analyses

How will the project address the needs?

- Will acquire relevant data from real high burnup fuel in real dry storage conditions
- Program can be used to support license renewal initiatives
- Data can be used to benchmark and improve analytical methods
- Data can be used to show effectiveness of cask drying process

Why North Anna?

- The HDRP is suited for a plant that uses a site-specific dry storage license
 - Can easily accommodate one-of-a-kind cask designs
- North Anna has bolted-lid cask experience
 - The HDRP cask is a bolted lid design AND it's the same type already used at North Anna
- North Anna has high burnup fuel with different cladding types already on site
 - Prevents transporting and licensing storage of various fuel designs at a designated cask loading site



Project Initiatives

(in a nutshell)

- Acquire the cask
- Modify the cask lid for instrumentation
- Develop a design and licensing basis document
- Plan the fuel loading
- Extract and ship sister rods
- Secure the license amendment
- Load fuel in the cask
- Store and monitor the cask at North Anna

Beyond the Project

- Transport the cask to an offsite fuel examination facility
 - Prevents re-wetting the fuel
- Open the cask
 - Conduct fuel exams at the offsite storage facility as necessary



The Cask

- The cask is a pre-existing TN-32 cask that has never been loaded
 - Certified for General License use
- The lid will be redesigned to support instrumentation and transportation
- A design and licensing basis document will support licensing the cask for use at North Anna



Fuel Selection

- Eighteen Areva AMBW Assemblies with M5™ Cladding
- Twelve Westinghouse NAIF Assemblies with Zirlo™ Cladding
- One Westinghouse NAIF Assembly with low-tin Zircaloy-4 Cladding
- One standard Westinghouse Assembly with Zircaloy-4 cladding

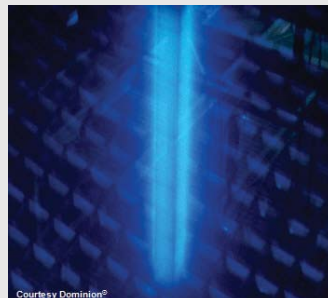


Fuel Payload Details

- Initial enrichment ranges from 3.59 w/o to 4.55 w/o
- Average assembly burnup ranges from 50.0 GWd/MtU to 55.5 GWd/MtU
- As of July 1, 2017
 - Payload decay heat is just under 37 kW
 - Decay times range from 5.3 years to 30.2 years
 - Assembly decay heat values range from 696 Watts to 1511 Watts
 - Average assembly decay heat is 1150 Watts
- Peak cladding temperatures during drying expected to be <340 degrees Celsius

Sister Rods

- 25 fuel rods from representative fuel assemblies
- These rods form the basis for pre-storage characterization
- Nine Areva M5™ rods
- Nine Westinghouse Zirlo™ rods
- Four Westinghouse Low-tin zircaloy-4 rods
- Three Westinghouse standard zircaloy-4 rods



Courtesy Dominion®

Sister Rods

- Rod extraction efforts underway
 - Phase 1 rods removed from fuel assemblies
 - Phase 2 rods to be extracted in June 2015
- Rods will be shipped to INL in first quarter 2016



NAC-LWT Cask

Licensing



- HDRP cask is a TN-32B cask
 - Initially fabricated and certified to meet CoC 72-1021 requirements
 - Not initially licensed for high burnup fuel
 - Cask is capable of storing high burnup fuels, but storage of high burnup fuel wasn't a priority at the time this cask was originally licensed
- High burnup fuel is already stored in casks at reactor sites across the country
- Dominion will seek a license amendment to North Anna's site specific ISFSI license
 - To permit storage of high burnup fuel in the TN-32B as well as address HDRP particulars

Licensing



- Areva-TN developed a Design and Licensing Basis Document (DLBD) to support Dominion's License Amendment Request (LAR)
 - The DLBD will provide the analytical bases and conclusions for departures from the existing approved analyses in the General License TN-32 FSAR
 - For example:
 - New lid design
 - New criticality safety analysis
 - Including additional neutron absorbers
 - New thermal analysis
 - New radiological analysis

- **Other LAR features**
 - **Instrumentation**
 - Thermocouple lances
 - **Separate Technical Specifications for the HDRP**
 - Will address modifications associated with the high burnup cask
 - In addition to current Tech Specs for existing TN-32 casks on the pad

Storage, Testing, and Monitoring

- **Cask cavity data acquisition will begin before the cask is drained**
 - Thermocouple data recorded on a data logger at regular intervals
- **After backfill and pressurizing, the cask will remain in cask prep bay for 2-3 weeks for cavity temperature, pressure, and gas composition monitoring**



Storage, Testing, and Monitoring

- **Cavity gas sampling**
 - Periodic cavity gas samples will be obtained and analyzed
 - Fission gas
 - Hydrogen content
 - Oxygen content
 - Moisture
 - Moisture data will provide immediate valuable insight to cask drying method

Storage, Testing, and Monitoring

- Tech Spec monitoring equipment will be installed at pad
 - Identical to existing North Anna TN-32 casks
 - Intended to be completely separate from Project monitoring

Storage, Testing, and Monitoring

- While on the pad...
 - Cask fuel and cavity monitoring
 - Fuel thermal data polled on regular basis (e.g. twice daily)
 - Data downloaded and reported on periodic basis (e.g., quarterly)
 - Cask cavity samples for composition analysis are planned on an infrequent basis
 - This process will continue until the cask is shipped offsite



High Level Milestone Schedule

- 12/31/14: TN completes DLBD
- 1/31/15: Phase 1 sister rods extracted
- 6/30/15: Phase 2 sister rods extracted
- 7/31/15: Dominion submits LAR to NRC
- 1Q16: Sister rod shipment
- 1/31/17: Expected NRC review completion
- 6/30/17: Dry run and functional tests complete
- 7/31/17: Cask loading complete – begin initial monitoring
- 8/21/17: Cask emplaced at pad/Begin at-pad monitoring