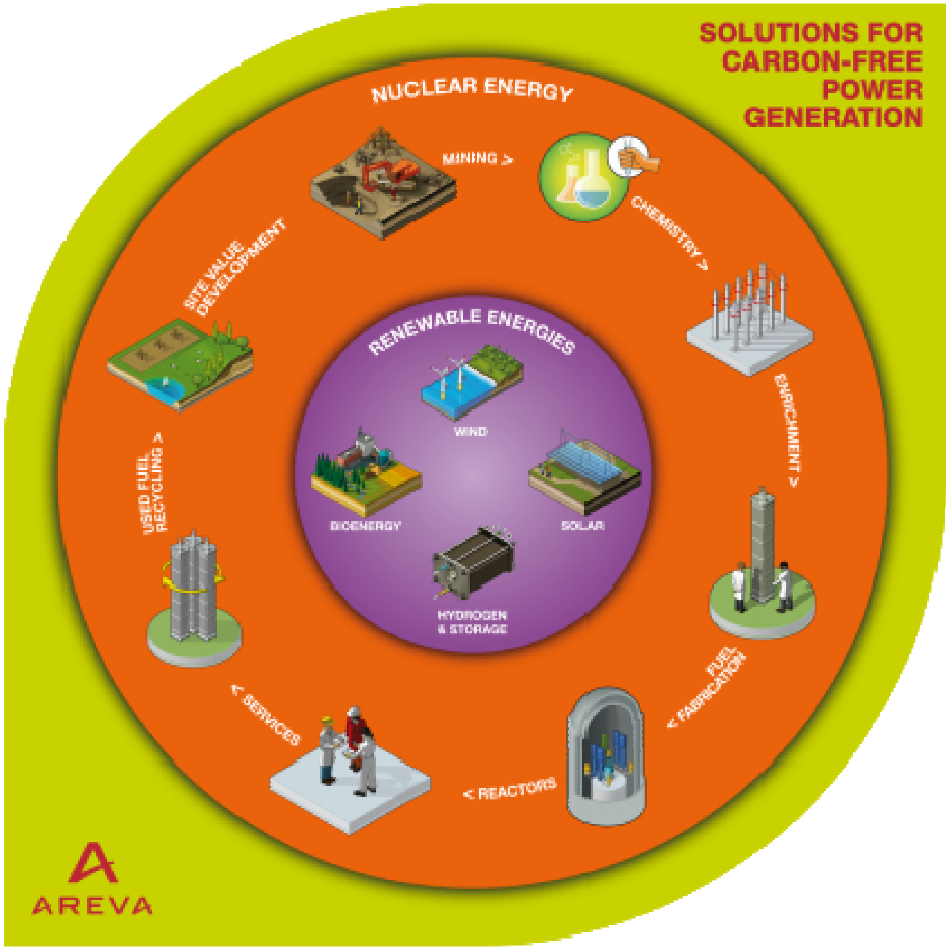
CoC 1029
Amendment 3
Pre-Application Meeting



Agenda

- **General Overview of Amendment 3 add the NUHOMS® 32PTH2 System to P72 CoC 1029**
  - **New 32PTH2 Canisters**
  - **New AHSM-HS Modules**
  - **No changes to the OS200FC TC cask.**
- **Incorporation of 32PTH2 Canister and AHSM-HS Modules into P72 CoC 1029.**
  - **32PTH2 Canister is similar to 32PTH1 approved under P72 CoC 1004, Amendment 10.**
  - **AHSM-HS modules are similar to HSM-HS modules approved under P72 CoC 1004 Amendment 10**
  - **Evaluated for transfer to ISFSI in OS200FC TC also approved under P72 CoC 1004 Amendment 10.**
- **Overview of Nuclear (Criticality and Shielding) Analyses for 32PTH2 and AHSM-HS**
- **Overview of Thermal Analyses for 32PTH2 and AHSM-HS**
- **Overview of Structural Analyses for 32PTH2 and AHSM-HS**
- **Questions**

Contents of Amendment 3

- No changes to existing 24PT1 or 24PT4 Systems
- No changes to existing AHSM Modules
- Incorporation of 32PTH2 Canister and AHSM–HS Modules into COC 1029
- Use of OS200FC TC from CoC1004 similar to OS197 TC
- Incorporation of transition details from existing AHSM array to new AHSM-HS array into CoC 1029

Incorporation of NUHOMS® - 32PTH2 and AHSM-HS System

- **32PTH2 Components**
  - **32PTH2 DSC-Similar to 32PTH1 as approved in CoC 1004 Amendment 10 except shell is Type 316 SST and thickness increased to 5/8” for better corrosion protection**
  - **Existing OS200 Transfer Cask**
- **AHSM-HS Components**
  - **Similar to existing HSM-H/HSM-HS Storage Modules approved in CoC 1004 Amendment 10 upgraded for higher siesmic values – 1.5g horizontally, 1g vertically.**
  - **Keys and module connections for high seismic similar to those used in AHSM design.**

32PTH2 System Configuration/Interfaces

32PTH2 DSC Basket Type		Max. Heat Load (kW) per DSC	Transfer Cask	Storage Module
Basket w/ Solid Aluminum Rails	MMC for neutron poison material	Up to 32 kW	OS200FC	AHSM-HS
		Up to 37.5 kW	OS200FC	

32PTH2 DSC Shell Assemblies

- **DSC Shell Assemblies are similar to existing shell assembly designs in CoC 1029 and previous COC 1004 Amendments.**
- **Shell assembly consists of:**
  - **5/8" thick cylindrical shell for added corrosion protection in a marine environment**
  - **Top and bottom inner and outer cover plates with thick carbon steel shield plugs**
- **Basket Assemblies**
  - **Basket designed for CE 16x16 class of fuels only**
  - **32PTH2 basket design is similar to 32PTH1 basket with solid aluminum rails for enhanced heat rejection**
  - **Basket uses MMC material with three different boron content to allow storage of various enrichment fuel.**

Existing OS200FC Transfer Casks

- **No Changes to OS200FC Transfer Casks Used for 32PTH1 System and described in CoC 1004 Amendment 10**

AHSM-HS Storage Modules

- Design based on existing HSM-H/HSM-HS Storage Modules with added shear keys and ties between bases for higher seismic loads.
- Seismic ties and keys are similar to the AHSM.
- Added the use of optional Dose Reduction enhancement hardware. Base shielding calculations are done without this hardware. No impact on structural and thermal performance
- Ability to couple existing AHSM array to new AHSM-HS array detailed in Amendment.

NUHOMS® 32PTH2

Tech Spec Overview of Changes

Kamran Tavassoli

November 08, 2011

Amendment 3 Technical Specifications (TS) and UFSAR Consistency Changes

- Recent interactions with NRC staff for CoC 1004 Amendments 11 and 13 have resulted in global editorial consistency changes in the TS.
- For CoC 1029 Amendment 3, these same changes are being made in the Technical Specifications, to achieve consistency and to enhance review of the amendment. As was done with CoC 1004, the CoC 1029 UFSAR is being updated as well.
- This will also be discussed in the amendment application and the specific changes will be described.

CoC 1029 Amendment 3 Technical Specifications Changes (1 of 3)

- Editorial changes made for clarity and consistency (e.g., “B-10”, “Zircaloy”, “U-235”, “UFSAR”)
- Definitions updated adding the 32PTH2 DSC, OS200FC TC, and AHSM-HS
- Section added providing requirements for fuel to be stored in the 32PTH2 DSC
- Added table for PWR fuel specification for the fuel to be stored in the 32PTH2 DSC
- Added table for PWR fuel assembly design characteristics for the 32PTH2 DSC
- Added tables for maximum assembly average initial enrichment v/s neutron poison requirements for the 32PTH2 DSC (intact fuel) and 32PTH2 DSC (damaged fuel)

CoC 1029 Amendment 3 Technical Specifications Changes (2 of 3)

- Added table for thermal and radiological characteristics for control components stored in the 32PTH2 DSC
- Added table providing B-10 specification for the 32PTH2 poison plates
- Added tables for PWR fuel qualification for the 32PTH2 DSC
- Added figure for four 32PTH2 DSC heat load zoning configurations
- Added LCO for 32PTH2 DSC bulkwater removal medium and vacuum drying pressure
- Added LCO for 32PTH2 DSC helium backfill pressure
- Added LCO for time limit for completion of 32PTH2 DSC transfer
- Added LCO for 32PTH2 DSC criticality control
- 32PTH2 DSC UFSAR basket neutron absorber testing and acceptance requirements incorporated by reference into the TS

CoC 1029 Amendment 3 Technical Specifications Changes (3 of 3)

- Added 32PTH2 ASME code alternatives tables for the basket and DSC shell
- Added minimum number of the AHSM-HS to be tied together
- Added reference to 32PTH2 system UFSAR sections to operating procedures requirements
- Added TC and AHSM-HS surface dose rate measurements to the Radiation Protection Program
- Added AHSM-HS to the thermal monitoring program
- Rearranged thermal monitoring steps to put them in chronological order, and added clarification for when the steps are applicable
- Added H2 Monitoring for 32PTH2 system
- Added marine environmental requirement for 32PTH2 system

NUHOMS® 32PTH2 DSC

Criticality and Shielding Evaluations

Prakash Narayanan

November 08, 2011

Criticality Analysis Overview

- Description of Spent Fuel Authorized Contents
- Criticality Analysis Methodology Description
  - Computer Code/Cross Section Library
  - Basic Computational Model
- Criticality Analysis for Intact and Damaged Fuel
- Criticality Benchmarks and USL Evaluation

Description of Spent Fuel Authorized Contents

- Up to 32 CE 16x16 Class Fuel Assemblies With or Without Control Components (CCs)
- Maximum Initial Enrichment of 5.10 wt. % U-235
- Intact Fuel Assemblies
  - Discrete Burnable Absorbers
  - Reconstituted Fuel Rods
- Damaged Fuel Assemblies
  - Missing Rods

Criticality Analysis Methodology Description

- Criticality Analysis Methodology is identical to that employed for the 32PTH1 DSC described in CoC 1004
- Criticality control based on favorable geometry, credit for fixed neutron absorbers in the basket and credit for 2600 ppm soluble boron
- Computer Code/Cross Section Library
  - CSAS5 module of SCALE6 Code with KENO V.a for Criticality Analysis
  - 44 Group ENDF/B-V Cross Section Library
  - NITAWL module for Cross Section Processing
- Basic Computational Model
  - 3D Model of the egg-crate basket section with fuel
  - DSC and Cask also modeled in radial direction
  - Periodic Axial and Reflective Radial Boundary Conditions
  - SCALE Standard Composition Library for Material Descriptions

Criticality Analysis for Intact and Damaged Fuel

- **Criticality Analysis for Intact Fuel**
  - **Determine the Most Reactive Fuel Parameters**
  - **Determine the Most Reactive Geometry and Material Configuration**
  - **Maximum Allowable Initial Enrichment as a function of fixed Poison loading and a soluble boron concentration of 2600 ppm**
- **Criticality Analysis for Damaged Fuel**
  - **Evaluate Various Postulated Damaged Assembly Configurations**
  - **Determine the Most Reactive Damaged Configuration**
  - **Maximum Allowable Initial Enrichment as a function of fixed Poison loading and a soluble boron concentration of 2600 ppm**

Criticality Benchmarks and USL Evaluation

- Criticality Benchmark Experiments described in NUREG CR/6361
- 118 experiments were evaluated to determine the USL
- Upper Subcritical Limit (USL-1) with USLSTATS Code
- The minimum USL is 0.9413

Source Terms and Shielding Analysis Overview

- Fuel Qualification Methodology Description
- Decay Heat Equation Methodology Description
- Response Function Methodology Description
- Source Terms Methodology Description
- Shielding Analysis Methodology Description

Fuel Qualification Methodology Description

- **Fuel Qualification Performed to determine loading Requirements for authorized contents from a shielding standpoint**
  - **Spent Fuel Loading per Heat Load Zoning Configurations (HLZCs)**
  - **Control Component Loading based on HLZC**
  - **Reconstituted Assemblies – Loading based on HLZC**
  - **Maximum Burnup 62.5 GWD/MTU, Minimum Cooling time 5 Years**
- **Spent Fuel Assembly Parameters Determined using Decay Heat Equation**
- **Fuel Qualification Table provides allowable Burnup and Enrichment combinations**
- **Design basis Spent Fuel parameters for Shielding calculations Determined with Response Function methodology**

Decay Heat Equation Methodology Description

- **Methodology identical to that employed in the NUHOMS® HD System (CoC 1030)**
- **Equation developed to calculate Decay Heat as a Function of Burnup, Enrichment and Cooling Time (BECT)**
- **SAS2H Module of SCALE Code System is employed to determine to Decay Heat for a variety of BECT Combinations**
- **Calculated Decay Heat values are fitted to a Multi-Parameter Equation**
- **Uncertainties from the Regression Analysis are included in the Decay Heat Equation**

Response Function Methodology Description

- Methodology Identical to that for the 32PTH1 System (CoC 1004)
- Response Function is a Source-to-Dose factor employed to rank Source Terms from Allowable BECT combinations
- The Maximum Dose Rates at select locations on the surfaces of the OS200FC TC and the AHSM-HS Modules are ranked
- Explicit MCNP5 Models with Multi-Zone loading are employed to determine the Response Functions
- SAS2H Module of SCALE is employed to determine the Source Terms for the various BECT combinations
- Spent Fuel Parameters for each Zone (for the OS200FC TC and AHSM-HS) that result in bounding Dose rates are determined
- The goal is to rank the BECT combinations and not to determine dose rates

Source Terms Methodology Description

- **Spent Fuel Source Terms are calculated using the bounding parameters from Response Function Results**
- **TRITON Module of SCALE6 with the 44-Group ENDF-B/V Cross Section Library employed to determine Source Terms**
- **Source Terms are calculated for the following:**
  - **Spent Fuel Assemblies using the bounding parameters from Response function results**
  - **Design Basis Control Components (CEAs)**
  - **Fuel Assemblies with Irradiated Steel rods**
  - **Fuel Assemblies with Natural Uranium Replacement rods**
- **Verification of Source Term calculations indicate that the SAS2H Models for Response Function and Decay Heat calculations are conservative**

Shielding Analysis Methodology Description

- Methodology is Identical and Models are Similar to 32PTH1 System for CoC 1004
- MCNP5 Version 1.4 with the Continuous Energy Cross Section Library employed to determine the Dose rates
- Fuel Assemblies modeled discreetly within Fuel Compartments
- Separate Models for Neutron and Gamma with Source Terms and Axial Distributions
- Subcritical Neutron Multiplication and Secondary Gamma Production included
- Flux-to-Dose Conversion Using ANSI/ANS-6.1.1-1977

Shielding Analysis Methodology Description

- **3D MCNP Models of 32PTH2 DSC / OS200FC TC for Decontamination, Welding and Transfer Operations**
  - **Maximum and Average Dose rates determined at Side, Top and Bottom of the TC**
- **3D MCNP Models of 32PTH2 DSC / AHSM-HS in Storage**
  - **Maximum and Average Dose rates determined at Roof, Front, Rear and Sides of the AHSM-HS**
  - **Dose rates also determined at Front and Roof Vent Openings**
  - **Dose rates calculated with and without Dose Reduction Hardware**
- **Generic 2x10 and 2-1x10 Array Site Dose Calculations**
  - **"Bootstrap Method" used to define Surface Sources of the ISFSI Array**
  - **Dose rate and Spectrum input from AHSM-HS results**
  - **ISFSI Dose rates calculated as a function of distance from Array**
- **Regulatory requirements met with sufficient margins**

NUHOMS® 32PTH2 System

Thermal Evaluations

Kamran Tavassoli

November 08, 2011

Thermal Analysis Overview

- **Thermal Evaluations for AHSM-HS Storage Module**
  - **Methodology reviewed by NRC for 24PTH / 61BTH / 32PTH1 systems in Appendices P, T, and U in CoC 1004 UFSAR and validated by testing**
  - **Maximum heat load of 37.2 kW**
  - **Include dose reduction hardware**

- **Thermal Evaluations for OS200FC Onsite Transfer Cask**
  - **Methodology reviewed by NRC in Appendix U of CoC 1004 UFSAR**
  - **Time limits specified for transfer operations for heat loads greater than 31.2 kW**

- **Thermal Evaluations for 32PTH2 DSC in AHSM-HS and in OS200FC Transfer Cask**
  - **Methodology reviewed by NRC for 32PTH1 and other DSCs in CoC 1004 UFSAR**
- **Supporting calculation: AHSM-HS air flow, Effective fuel assembly properties, DSC basket properties, DSC internal pressure, and thermal expansion**

Thermal Evaluation for Storage Conditions

- **ANSYS 3D Model of AHSM-HS with DSC shell and homogenized basket**
- **Boundary conditions and loading**
  - **Loaded with 32PTH2 DSC with 31.2 kW, 32 kW, 35.2 kW, and 37.2 kW heat loads**
  - **Insolation, convection, radiation to ambient**
  - **Normal, off-normal and accident conditions**
- **Boundary condition and properties based on results from three supporting calculation**
  - **Airflow in AHSM-HS including dose reduction hardware, including 50% inlet vent blockage**
  - **Homogenized basket properties**
    3D slice model
  - **Fuel assembly effective thermal properties**
    2D model, CE16x16 class FA, irradiated with 62.5 GWd/MTU burnup

Thermal Evaluation for Storage Conditions

- **Analysis performed for Steady-State and Transient (**Blocked Vent Accident**) Conditions**

- **Summary of Preliminary Results**
  - **Maximum concrete temperature for all normal/off-normal conditions remains below the limit of 300°F. For the blocked vent accident condition, maximum concrete temperature remains below 450°F**
  - **Analysis provide DSC shell temperatures for 32PTH2 DSC analysis for steady-state and transient storage conditions.**

Thermal Evaluation for Transfer Conditions

- **ANSYS 3D Model of OS200FC transfer cask with DSC Shell and homogenized basket**
  - **OS200FC model without air circulation uses SOLID/SHELL elements**
  - **OS200FC model with air circulation uses FLUID elements**
    - This model is benchmarked against the SINDA/FLUINT model reviewed in Appendix U of CoC 1004.
    - The benchmarked model is also used in Appendix T, Section T.4.5.6 under review in Amendment 13.

- **Boundary conditions and loading**
  - **Loaded with 32PTH2 DSC with 31.2 kW, 32 kW, 35.2 kW and 37.2 kW heat loads**
  - **Heat generation applied to homogenized basket**
  - **Insolation, free convection and radiation to ambient**
  - **Normal, off-normal and accident conditions**

Thermal Evaluation for Transfer Conditions

- **Analysis performed for Steady-State and Transient** (Operations with time limits) **Conditions**

- **Summary of Preliminary Results**
  - **Maximum OS200FC transfer cask temperatures remain below the limits**
  - **For heat load ≤ 31.2 kW no time limit for transfer operation**
  - **For other heat loads time limits are calculated for transfer operation**

  - **Analysis provide DSC shell temperatures for 32PTH2 DSC analysis for steady-state and transient transfer conditions.**

Thermal Evaluation of 32PTH2 DSC for Storage

- **ANSYS 3D Model of DSC and Basket**
  - Includes all gaps
  - 0.37” paired aluminum/poison plate

- **Boundary condition and loading**
  - Heat Loads of 31.2 kW, 32 kW, 35.2 kW, and 37.2 kW (4 HLZCs)
  - Heat generation applied to homogenized fuel assemblies with peaking factors
  - DSC shell temperatures are from AHSM-HS model
  - Steady-state for normal/off-normal and transient model for storage accident conditions (blocked vents)

- **Summary of Preliminary Results**
  - Maximum fuel cladding and DSC component temperatures for storage conditions are lower than the allowable limits
  - Provides temperature history for blocked vent accident conditions
  - Provides average component temperatures to calculate DSC internal pressure and thermal expansion

Thermal Evaluation of 32PTH2 DSC for Transfer

- **3D Model of DSC and Basket**
  - **Identical to the model used for storage conditions**

- **Boundary condition and loading**
  - **Heat Loads of 31.2 kW, 32 kW, 35.2 kW, and 37.2 kW (4 HLZCs)**
    - Heat load of 37.2 kW is considered bounding for heat load of 35.2 kW
  - **DSC shell temperatures are from OS200FC TC model**
  - **Steady-state models for transfer conditions without time limits**
  - **Steady state model for the bounding accident conditions**
    - Loss of liquid neutron shield plus loss of air circulation
  - **Transient model for transfer conditions with time limits**
    - Fire accident is bounded by loss of liquid neutron shield plus loss of air circulation
  - **Damaged fuel assemblies considered as rubble for drop accident conditions**

Thermal Evaluation of 32PTH2 DSC for Transfer

- **Summary of Preliminary Results**
  - **Maximum fuel cladding and DSC component temperatures for transfer conditions are lower than the limits**

Proposed Time limits:

- **For heat load >32 kW to ≤37.2 kW , time limit of 36 hours**
- **For heat load >31.2 kW to ≤ 32 kW, time limit of 75 hours**
- **For heat load ≤ 31.2 kW no time limit**

- **Analysis provide DSC shell temperatures for 32PTH2 DSC analysis for steady-state and transient transfer conditions.**

DSC Internal Pressure

- **Ideal Gas Law used for DSC Internal Pressure**
  - **Average gas temperatures from DSC/Basket Model**
  - **Fission gases are calculated for 62,500 MWd/MTU burnup**

- **Summary of Preliminary Results**
  - **Internal DSC pressures remain well below the design pressures**

Operating Operations	Calculated Pressure (psig)	Design Pressure (psig)
Normal	9.24	15
Off-normal	16.7	20
Accident	108	140

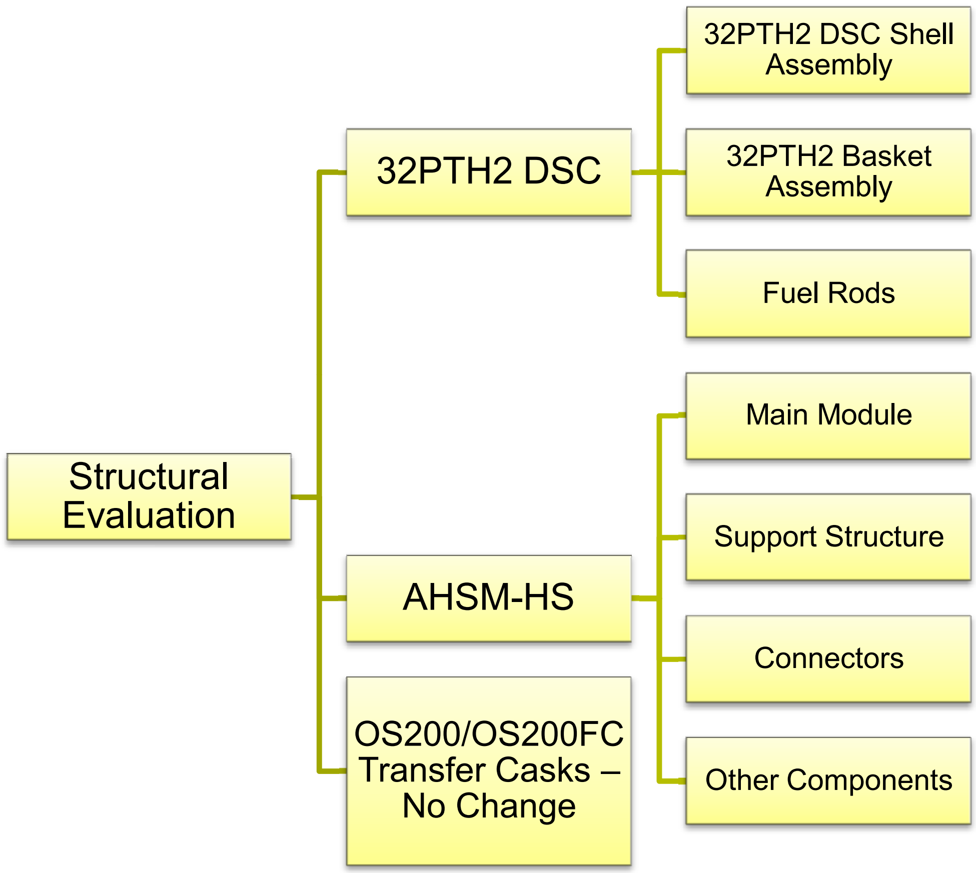
NUHOMS® 32PTH2 DSC

Structural Evaluations

Raheel Haroon

November 08, 2011

Overview of Structural Evaluation



32PTH2 DSC Shell Assembly

- Analysis approaches are the same as the 32PTH1 DSC for CoC 1004 Amendment 10
- Design similar to 32PTH1 DSC
- Design meets ASME Subsection NB and Appendix F requirements
- Design of the top closure welds meets the ISG-15/18 requirements
- Hand calculation, 2D and 3D ANSYS equivalent static analyses performed for all load cases

32PTH2 Basket Assembly

- Hand calculation and ANSYS equivalent static analyses performed for all load cases except the side drop evaluation
  - Analysis approaches are the same as the 32PTH1 DSC for CoC 1004 Amendment 10
- Dynamic analyses using LS-DYNA are performed for side drop analysis
  - Analysis approach is the same as the 37PTH DSC for CoC 1004 Amendment 13 (currently under NRC review)
- Design similar to 32PTH1 basket assembly
- Design meets the ASME Subsection NG and Appendix F requirements
- Maximum creep strain in the Aluminum rails is less than 0.01 after 60 years of storage

Fuel Rods

- **Intact Fuel**
  - **Side and corner drop analyses are performed for intact fuel to show no permanent deformation of the fuel rods**
  - **Analysis approaches are the same as the latest approved methodologies**
- **Damaged Fuel**
  - **Evaluated for normal and off-normal loads**
  - **Analysis methodology is the same as the CoC 1004 Amendment 10**

AHSM-HS

- Analysis approaches are similar to the AHSM analyses in CoC 1029 Amendment 1
- Design similar to HSM-HS
- Concrete design meets ACI 349-06
- Steel design meets AISC 13th Edition
- Stress analyses performed for
  - Main Module (FEA)
  - Support Structure (FEA)
  - All other components (Hand calculations + FEA)
  - All connectors meet ACI 349-06 Appendix D and AISC 13th Edition requirements
- Stability analyses performed for
  - Seismic (LS-DYNA non-linear time history analyses)
  - Non-Seismic (Hand calculations)