SAFETY EVALUATION REPORT

DOCKET NO. 72-8
CALVERT CLIFFS
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
MATERIALS LICENSE NO. SNM-2505
AMENDMENT NO. 9

1 SUMMARY

This Safety Evaluation Report (SER) documents the review and evaluation of an amendment request (LAR 09-001) to Special Nuclear Materials (SNM) License No. 2505 for the Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI). By letter dated June 15, 2009, as supplemented February 18, March 31, May 6, and September 1, 2010, Calvert Cliffs Nuclear Power Plant, LLC (CCNPP) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 72.56, to amend the Technical Specifications (TS) to increase the stored fuel assembly burnup limit of 47,000 MWd/MTU to 52,000 MWd/MTU in the Transnuclear, Inc. (TN) NUHOMS®-32P dry storage cask (DSC) system.

The NRC staff has reviewed the application, including the justifications for the requested changes. As discussed in further detail below, based on the statements and representations in the application, as supplemented, the staff finds that the requested amendment to the TS of the Calvert Cliffs ISFSI meets the regulatory requirements of 10 CFR 72.

LAR 09-001 requested the following revisions to the TS:

1.1 Revision of TS 2.1, “Fuel to be Stored at ISFSI,” to allow an increase in the limit on the neutron and gamma sources allowed for each fuel assembly,

1.2 Revision to TS Limiting Condition for Operation (LCO) 3.1.1(3), “Fuel to be Stored at ISFSI,” to increase the maximum allowable assembly average burnup limit from 47,000 to 52,000 MWd/MTU for the NUHOMS®-32P DSCs,

1.3 Revision to TS LCO 3.4.1.1, “Maximum Air Temperature Rise,” to increase the allowable air temperature rise from the HSM [horizontal storage module] inlet to the HSM outlet from 60^{o} F to 64^{o} F.

2 BACKGROUND

The Calvert Cliffs ISFSI is co-located on approximately 3.5 acres with Calvert Cliffs Nuclear Power Plants, Units 1 and 2, on the west shore of the Chesapeake Bay in Calvert County, Maryland. The ISFSI can accommodate up to 120 NUHOMS® Horizontal Storage Modules (HSMs). The Calvert Cliffs ISFSI was originally licensed to store dry spent nuclear fuel in

NUHOMS®-24P DSCs. On November 7, 2005, the NRC issued Amendment No. 7 to SNM-2505 which authorized use of the NUHOMS®-32P DSC system for increased storage capacity.

3 REVIEW CRITERIA

The staff's evaluation of the requested changes are based on ensuring CCNPP continues to meet the applicable requirements of 10 CFR Part 72 for independent storage of spent fuel and of 10 CFR Part 20 for radiation protection. The staff followed the guidelines provided in NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities" in conducting its evaluation. The staff's evaluation focused only on changes to SNM-2505 and associated TS requested in the application and did not reassess previously approved portions of the license, TS, and the Updated Safety Analysis Report (USAR) or those areas of the USAR modified by CCNPP as allowed by 10 CFR 72.48. The objectives for the following review disciplines are as described below for each of the requested changes.

4 SSC AND DESIGN CRITERIA EVALUATION

The requested changes do not impact adversely safety functions of the original SSC design. Therefore an evaluation was not required.

5 STRUCTURAL EVALUATION

5.1 Discussion

The purpose of this safety evaluation is to verify that the Zircaloy-4 cladding with maximum average assembly burnup to 52,000 MWd/MTU can maintain its structural integrity under a postulated transfer cask accident condition. The design basis of a postulated accident condition for the loaded transfer cask (TC) with the DSC and its internals is an 80-inch cask handling height drop scenario including end, side, and oblique drops onto a 3-foot thick reinforced concrete slab backed by well compacted sand and/or gravel at the CCNPP site.

The structural issue regarding the requested change to the high burn-up fuel conditions is the effect this change will have on the cladding response during postulated drop accident conditions. At increased maximum average assembly burn-up levels, the cross sectional properties of the cladding and the ductility limit of the Zircalloy-4 are the two features that are relevant to impact scenarios. Considering the highly nonlinear response of a fuel pin due to an end-drop scenario, a transient dynamic evaluation method was considered to be more appropriate than a quasi-static evaluation. Therefore, a new evaluation of the cladding integrity for the postulated transfer cask accident conditions, using updated cladding thickness and material properties, is required.

The licensee presented evidence for the acceptability of this change based on the following three TN calculation packages:

1. NUH32P+.0201, Rev. 1, titled "NUHOMS® 32P CE 14X14 Fuel Cladding Strength under Accident Side Drop Conditions." This is a quasi-static single pin side drop analysis using the ANSYS finite element analysis (FEA) code.

2. NUH32P+.0203, Rev. 0, titled: “32+ Transfer Cask Impact onto the Concrete Pad LS_DYNA Analysis (80 inch End-drop).” This is an explicit dynamic end-drop impact analysis of the NUHOMS 32P transfer cask using the LS-DYNA FEA code. The detailed 3 Dimensional (3D) model of the cask impacts with a 3D volume of nonlinear concrete slab and linear soil.
3. NUH32P+.0204, Rev 1, titled: "Fuel End-Drop Analysis for NUH32P+ Using LS_DYNA." This is an explicit dynamic end-drop single pin analysis using the LS-DYNA FEA code to determine the maximum principal strain in the fuel cladding based on the cask impact response from NUH32P+.0203, Rev. 0. Two versions of the single pin model were included in the calculation package, Model I and Model II, with the principal difference between them being the method of applying a deceleration history as a load to the pin. Both models used the cask impact model results from NUH32P+.0203, Rev. 0, as a basis for their loading conditions, but Model I used an idealized impact limit representation to load the pin and Model II used a forcing function.

The NUH32P+.0201, Rev. 1, calculation package represents a common quasi-static model methodology for side drop applications that is identical to previously approved analyses. The NUH32P+.0203, Rev. 0, and NUH32P+.0204, Rev. 1, calculation packages represent a new approach to evaluate fuel pin response to an end-drop scenario onto a reinforced concrete slab. While some features of the two LS-DYNA models were used in past licensing applications, this methodology as a whole required careful review and consideration. A significant number of independent confirmatory analyses were performed by the staff to support this structural evaluation, and the conclusions were based on both the applicant’s numerical model results and the confirmatory model results.

5.2 Side Drop Impact Evaluation

The methodology employed by NUH32P+.0201, Rev. 1, is identical to previously approved models. The staff reviewed the model, and found the results acceptable.

5.3 End-Drop Impact Evaluation

The LS-DYNA calculations in NUH32P+.0204, Rev 1, represent a postulated 80-inch drop of the transfer cask onto a reinforced concrete slab. Results are presented for two similar single pin models, Model I and Model II, relying on different methods to characterize responses at the interface between the cask bottom and the concrete slab. Model I uses an impact limiter approximation to match the frequency-filtered displacement of the transfer cask end. Model II uses a forcing function method to directly represent the unfiltered response of a specific node in the impact end of the cask. Model II is recognized as the one that more appropriately captures the physics of the impact response.

Additional confirmatory analyses were conducted by the staff, and they are supportive of the results of NUH32P+.0204, Rev 1, in that they predict the pin will experience an acceptable level of maximum principal strain during a postulated cask drop event.

5.4 Evaluation findings

F5.1 The three calculation packages noted above and the staff's independent confirmatory analyses provide reasonable assurance that the cladding will maintain its structural integrity during the postulated 80-inch drop at the CCNNP site. Therefore, the staff finds that the regulatory requirement of 10 CFR Part 72.122 is met.

6 THERMAL EVALUATION

6.1 Review of Requested Changes

The following requested TS changes have minimal impacts on the thermal performance of NUHOMS®-32P system:

1) LCO 3.1.1 (3), Fuel to be Stored at ISFSI – This TS ensures that the fuel assemblies stored in the DSCs meet the design requirements of the canisters. The existing burnup limit is 47,000 MWd/MTU. The requested change would increase the burnup limit to 52,000 MWd/MTU for the NUHOMS®-32P DSCs while the burnup limit of 47,000 MWd/MTU would remain for the NUHOMS® -24P DSCs.

2) LCO 3.4.1.1, Maximum Air Temperature Rise – This TS limits the air temperature rise from the HSM inlet to the outlet. It provides assurance that the fuel is being adequately cooled while in the HSM. The requested amendment would raise the allowable air temperature rise from the HSM inlet to the HSM outlet from 60°F to 64°F.

A revised version of the Vacuum Drying Analysis, was provided in the application. Upon the staff's review, the maximum predicted fuel cladding temperature allowable for steady state, vacuum drying at 110 hours, and helium, steady-state backfilling conditions were found to fall below the maximum fuel cladding temperature allowable for normal conditions of storage. Table provides the predicted fuel cladding temperatures versus the maximum allowable fuel cladding temperature.

Table 1: Maximum Predicted Temperatures during Normal Conditions of Storage

Condition	Maximum Predicted Temperature (°F)	Maximum Allowable Temperature (°F)
Vacuum Drying at 110 hours	722	752
Vacuum Drying at Steady State	742	752
Helium Backfilling at Steady State	536	752

6.2 Conclusions

The staff finds the changes requested to the NUHOMS®-32P DSCs have minimal impact on the thermal performance of the system and are, therefore, acceptable.

6.3 Evaluation Findings

F6.1 There were no changes to the thermal Structures, Systems, Components (SSCs) important to safety in this amendment request, therefore, all cask SSCs important to safety continue to remain within their operating temperature limits.

F6.2 The staff has reasonable assurance that the spent fuel cladding will be protected against degradation that leads to gross ruptures by maintaining the clad temperature below maximum allowable limits and by providing an inert environment in the cask cavity.

F6.3 The staff finds that the thermal design of the system is in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the system will continue to allow safe storage of spent fuel for a certified life of 20 years. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

7 SHIELDING EVALUATION

7.1 Review of Requested Changes

In this amendment request, the licensee requested approval to change the existing TS 2.1, which currently specifies a maximum average burnup limit of 47,000 MWd/MTU, to a higher maximum average burnup of 52,000 MWd/MTU for the NUHOMS®-32P DSC to allow for more of the horizontal storage modules HSMs to be utilized at the facility. The burnup limit for the NUHOMS®-24P would remain the same.

The NUHOMS®-32P has 32 stainless steel guide sleeves holding 32 spent fuel assemblies using an egg-crate design made of stainless steel and aluminum to support the guide sleeves. The guide sleeves and egg-crate components run the length of the canister.

TS 2.1 currently limits spent fuel stored in the both the NUHOMS®-24P and NUHOMS®-32P DSC to load a neutron source of $<3.3\text{x}10^{8}$ neutrons/second/assembly and a gamma source term of $<1.53\text{x}10^{15}$ MeV/second/assembly. The requested change to TS 2.1 would increase the neutron source to $<4.175\text{x}10^{8}$ neutrons/second/assembly for the NUHOMS®-32P DSC. The gamma source per assembly for the NUHOMS® -32P DSC would be increased to $<1.61\text{x}10^{15}$ MeV/second/assembly (i.e. $4.67\text{X}10^{15}$ photons/second/assembly), while the gamma source per assembly for the NUHOMS®-24P DSC would be maintained at the current level. The difference between the gamma sources is due to the possibility that fuel waiting to be stored may exceed the current limit of $<2.23\text{x}10^{8}$ neutrons/second/assembly. The higher neutron source per assembly will allow the fuel to be stored in the NUHOMS®-32P DSC versus the NUHOMS®-24P DSC. The licensee requested changes to TS 2.1 to establish new neutron and gamma source term limits allowed in each fuel assembly using the same methodology as previously approved for this design. Although Interim Staff Guidance (ISG)- 6 states that the SAR should not attempt to establish specific source terms as operating controls and limits for cask use, the staff finds the licensee's approach in this instance acceptable in order to avoid altering the licensing basis of loaded NUHOMS®-24P and -32P DSCs that have been loaded prior to this amendment (63 in total). In order to provide additional justification to supplement the changes to TS 2.1, a specific fuel qualification table for the NUHOMS®-32P DSC was added to ISFSI USAR Table 9.4.1 using information in Calvert Cliffs Calculation CA06721 to indicate cooling times for the CE14x14 that is used by the applicant. The staff finds that this is adequate justification for the requested amendment at this time.

The contact dose rate for the higher average burnup NUHOMS®-32P DSC in a loss of neutron shielding accident increased from 1517 mrem/hour to 1751.7 mrem/hour. At 15' the dose rate was calculated to be 145.5 mrem/hr. During an 8-hour period the total dose would be 1164 mrem at 15' and represents a minimal increase in the consequences of an accident. These values are within the limits of 10 CFR 72.106. The dose rates for normal transfer cask configuration meet the design goal of less than 5 rem at the site boundary.

7.2 Conclusions

The staff reviewed the dose rate calculations and the additional information submitted by the licensee to support the new neutron and gamma source terms. The staff performed confirmatory calculations using ORIGEN-ARP to verify the new source terms. Therefore, staff has reasonable assurance that the NUHOMS®-32P will maintain doses less than those specified in 10 CFR 72.104 and 72.106 under the requested higher average burnup limit of 52,000 MWd/MTU.

7.3 Evaluation Findings

F7.1 The staff finds that the shielding design of the system remains in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied.

8 CRITICALITY EVALUATION

8.1 Review of Requested Changes

Since there are no physical changes to the NUHOMS®-32P DSC system, the transfer cask, or the horizontal storage modules, as well as no changes to the standard CE 14x14 fuel assembly physical dimensions, weight, or maximum initial enrichment (i.e., 4.5 wt% ^{235}U) the criticality safety of the design remains unchanged. The staff performed confirmatory calculations of the bounding criticality safety case using the SCALE5.1 system of codes as an alternate code to note any unforeseen differences versus the SCALE4.4a calculations that had been performed previously and found the multiplication factors to be in close agreement with those found by the original calculations.

8.2 Evaluation Findings

F8.1 The staff finds that the criticality design of the system remains in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied.

9 CONFINEMENT EVALUATION

9.1 Review of Requested Changes

The staff reviewed the requested changes and concluded that the changes have minimal impact on the ability of the NUHOMS®-32P DSCs to provide confinement of the radionuclides that are present in the spent fuel assemblies stored in those DSCs.

9.2 Evaluation Findings

F9.1 The staff finds the changes acceptable and that the NUHOMS®-32 DSC system employed at the Calvert Cliffs Nuclear Power Plant ISFSI will continue to meet the requirements of 10 CFR Part 72 for the confinement of radionuclides.

10 CONDUCT OF OPERATIONS

The requested changes do not impact the original conduct of operations evaluation. Therefore an evaluation was not required.

11 RADIATION PROTECTION EVALUATION

The requested changes do not impact the original radiation protection evaluation. Therefore an evaluation was not required.

12 QUALITY ASSURANCE EVALUATION

The requested changes do not impact the original quality assurance evaluation. Therefore an evaluation was not required.

13 DECOMMISSIONING EVALUATION

The requested changes do not impact the original decommissioning evaluation. Therefore an evaluation was not required.

14 WASTE CONFINEMENT AND MANAGEMENT EVALUATION

The requested changes do not impact the original waste confinement and management evaluation. Therefore an evaluation was not required.

15 ACCIDENT ANALYSIS

The evaluation is provided in section 8.

16 TECHNICAL SPECIFICATIONS

TS Changes are documented and evaluated in previous sections to this SER.

17 MATERIALS EVALUATION

17.1 Review of Requested Changes

The amendment requests increasing the burnup limit of Combustion Engineering 14 x 14 fuel assemblies from 47,000 MWd/MTU to 52,000 MWd/MTU. As a result of increasing the burnup limit, the applicant conservatively estimated that the fuel cladding thickness is reduced by 71 microns (0.00281 inches) using a Pilling-Bedworth factor of 1.75 and an oxide thickness of 125 microns (0.00492 inches). The maximum allowable strain of the Zircaloy is 1.5%. These changes are acceptable to the staff. The definitions of intact and undamaged fuel as specified in the TS are consistent with guidance found ISG - 1, Revision 2, “Damaged Fuel.” During loading operations, inert gas or air will be used to blow down the spent fuel. The use of inert gas precludes further oxidation of the pellets, and the potential for rod splitting. Air will only be used when intact fuel (no cladding breaches) is loaded into a canister, thereby precluding further oxidation of the pellets, and the potential for rod splitting. The staff finds the use of inert gas or air (under the specified conditions) for blow down acceptable. Loading operations will not result in repeated thermal cycling of the fuel, and the fuel will be maintained below 400^{o}C during loading and storage, consistent with the guidance provided in ISG - 11, Revision 3, “Cladding Considerations for the Transportation and Storage of Spent Fuel.”

17.2 Evaluation Findings

F17.1 The staff finds that the materials design of the system remains in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied.

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