# SAFETY EVALUATION REPORT
# TO ALLOW THE ADDITION OF BURNABLE POISON ROD ASSEMBLIES

**DOCKET NO. 72-1004**
**MODEL NOS. STANDARDIZED NUHOMS® -24P and -52B**
**TRANSNUCLEAR WEST, INC.**
**CERTIFICATE OF COMPLIANCE NO. 1004**

## SUMMARY

Currently, the Certificate of Compliance for the NUHOMS®-24P horizontal modular storage system is approved only for storage of spent fuel assemblies. By letter dated July 26, 1999, as supplemented, Transnuclear West Inc. (TN West) submitted an application for Amendment No. 3 to Certificate of Compliance No. 1004. TN West requests approval to add burnable poison rod assemblies (BPRAs) for the Babcock and Wilcox (B&W) 15x15 and Westinghouse 17x17 fuel assembly types to the authorized contents of the NUHOMS®-24P horizontal modular storage system long cavity dry shielded canister (DSC). The staff performed a detailed safety evaluation of the proposed amendment request and determined that the addition of the BPRAs to the B&W 15x15 and Westinghouse 17x17 fuel assembly types meets the requirements of 10 CFR Part 72.

## 1.0 STRUCTURAL

This section presents the results of the structural design review of the NUHOMS®-24P long cavity DSC for the addition of BPRAs for B&W 15x15 and Westinghouse (WE) 17x17 fuel assembly types to be added as authorized contents. The purpose of this review is to verify that the DSC design is not adversely affected by the addition of BPRAs and that the DSC meets the structural requirements of 10 CFR Part 72.

The impact of the addition of BPRAs in the fuel assembly on the DSC structural design was evaluated by comparing the changes in the structural parameters, which may impact adversely on the DSC design. The significant structural parameters affected by the addition of BPRAs are the weight of the fuel assembly, center of gravity of the mass, temperatures, and internal pressures. Each of these parameters are reviewed below.

**Weight of the Fuel Assembly**

The application states that the maximum weight of the fuel assemblies with BPRAs is enveloped by the weight used in the Nuclear Regulatory Commission approved design basis for the DSC and the NUHOMS® storage system. The staff independently evaluated this as shown below.

| PWR Fuel Assembly type | Weight of the Fuel (Ref. 1: Table 3.1-3) | Weight of the BPRAs (Ref. 3) | Total Weight of the fuel assembly w/BPRAs |
|---|---|---|---|
| BW 15 x 15 | 1515 lbs (688 kg) | 71 lbs (32 kg) | 1588 lbs (720 kg) |
| WE 17 x 17 | 1466 lbs (665 kg) | 39 lbs (18 kg) | 1505 lbs (683 kg) |

Appendix H of the applicant's Safety Analysis Report (SAR (Ref. 1)) provides justification for a long cavity canister design and Section H.1.1 refers to the NUHOMS®-24P Topical Report (TR) (Ref. 2) for qualification, including the structural requirements. The TR Section 3 provides information on the maximum fuel assembly weights used for the design of the cask. Table 3.1-1 of the TR and Table 3.1-1 of the SAR specify the maximum assembly weight as 1682 lbs (763 kg).

As noted above, the revised maximum weight of the fuel assembly with BPRAs is 1588 lbs (720 kg) and is less than the original maximum design weight of 1682 lbs (763 kg). Therefore, the staff concludes that the weight of the cask with BPRAs is enveloped by the approved design basis of the DSC, and additional weight of the BPRAs will not adversely impact the DSC design.

**Center of Gravity of the Mass**

The applicant stated (Ref. 4) that the center of gravity of a loaded cask with and without BPRAs is located within 1.0 inch and that this is insignificant compared to the cask height of approximately 200 inches. The staff agrees with the assessment and the conclusion that there is no adverse impact on the DSC design.

**Temperature Changes**

There are no changes in design temperatures due to the addition of BPRAs. Therefore, the DSC design is not affected.

**Pressure Changes**

The applicant calculated the internal pressure changes in the DSC due to the addition of BPRAs and states that the off-normal pressure increases by 6 percent. The staff reviewed the design basis SAR and concludes that the DSC design has sufficient margins to accommodate the 6 percent increase in stresses due to the internal pressure.

In addition, the governing load combinations with the off-normal pressure are ASME III Level B conditions, for which the SAR limits the stresses to ASME III Level A stress allowables. Since the Level B stress allowables are 10 percent higher than the Level A allowables, the present DSC design has additional margins to accommodate the 6 percent increase in stresses due to off-normal pressure.

Based on the above, the staff concludes that the pressure changes do not adversely affect the DSC structural design.

The staff reviewed applicable sections of the SAR to evaluate the effects, if any, of intimate contact between the BPRAs and the internal hardware. In particular, materials selection and chemical reactions were reviewed. The staff concluded that the materials selected for the BPRAs are inert to the DCS environment and are not expected to be reactive with the cask internal components under all conditions of service during the licensing period.

The staff concludes that the addition of BPRAs will not adversely affect the DSC and the NUHOMS®-24P storage system and that the structural performance of the NUHOMS® storage system meets the structural requirements of 10 CFR Part 72.

## 2.0 THERMAL

The applicant stated that no recalculation of any of the original thermal analysis for the cask was necessary to qualify BPRAs. The staff reviewed the applicant's analysis of decay heat in the NUHOMS®-24P DSC and found the analysis to be adequate. The results are presented below.

### Decay Heat

The applicant calculated the maximum heat generation of the BPRA components to be 8 watts from each assembly. The applicant also created a new fuel qualification table to address the addition of the heat generated by the BPRAs. The total decay heat of each spent fuel assembly is taken to be that generated by the fuel plus the decay heat generated by the BPRAs. The criteria for fuel cladding temperature limit remains the same, but the allowable decay heat from the fuel rods in an assembly is reduced by 8 watts to accommodate the BPRAs. Therefore, the applicant concluded that the results from the thermal analysis in Chapter 8 of the SAR (Ref. 1) for normal, off-normal, and accident conditions remain valid for the maximum design basis decay heat of 1 kW per assembly, including the BPRA contribution. The staff reviewed the applicant's analysis and agrees with this conclusion and finds that the NUHOMS®-24P storage system meets the thermal requirements of 10 CFR Part 72.

## 3.0 CONTAINMENT

The applicant provided an evaluation of the pressure inside the DSC under normal, off-normal, and accident conditions, based on the addition of gasses to the DSC from the BPRAs. The

applicant calculated the maximum number of moles of Helium gas that could be generated in each BPRA during reactor operations.  The applicant assumed that 30% of the Helium gas produced in the Aluminum Oxide ($Al_2O_3$) composite (within the BPRA rods) is released into the BPRA rod void volume and is available for release into the DSC cavity in the case of a BPRA rod rupture.  The applicant then calculated the total number of moles of Helium gas for 24 B&W BPRAs (with 16 rods each) inside a DSC.  The B&W 15x15 BPRAs bound the Westinghouse 17x17 BPRAs for the DSC internal pressure calculations.

For normal and off-normal conditions, the applicant assumed a Helium gas release from 1% and 10% of the BPRA rods, respectively.  For hypothetical accident conditions, the applicant assumed a release of Helium gas from 100% of the BPRA rods.  The applicant analyzed pressures for 40 and 45 GWd/MTU burnup fuel.  A summary of the results of the applicant's analysis is shown below.

**Summary of DSC Internal Pressure Evaluation Results**
**for Normal, Off-Normal, and Accident Conditions**

| Operating Condition | Limiting Case Description | 40 GWd/MTU Burnup Pressure (psig) | 45 GWd/MTU Burnup Pressure (psig) | Design Basis Pressure (psig) |
|---|---|---|---|---|
| Normal | DSC in Cask, 100°F | 7.1 | 6.8 | 10 |
| Off-Normal | DSC in Cask, 100°F | 10.6 | 10.2 | 10 |
| Accident | Blocked HSM Vents, 125°F | 56.1 | 59.8 | 60 |

For the normal and off-normal cases, the 40 GWd/MTU burnup fuel is bounding.  For the accident case, the 45 GWd/MTU burnup fuel is bounding.  The pressures calculated in all cases are below the design basis pressures for the 24P long cavity DSC.

The staff reviewed the applicant's calculations and determined that the calculations were based on conservative assumptions for the amount of Helium produced, the percentage of Helium released into the void volume (30%), and the number of BPRAs in a single DSC (24).  Based on the staff's review, the staff agrees with the applicant's conclusion that the DSC internal pressure with BPRAs for normal, off-normal, and accident conditions does not exceed the design basis pressure values presented in the previous analysis for the NUHOMS® storage system.  Based on this analysis, storage of BPRAs in the NUHOMS®-24P long cavity DSC meets the containment requirements of 10 CFR Part 72.

## 4.0 SHIELDING

The effect on dose rates due to the inclusion of 24 irradiated BPRAs into B&W 15x15 or Westinghouse 17x17 fuel assembly types, loaded into the NUHOMS®-24P, was re-analyzed by

the applicant. The applicant used the ORIGEN2 computer code to calculate the source terms for the BPRAs and determined that the bounding BPRA was the B&W 15x15 having burned 36,000 MWd/MTU and 3.3% w/o U-235. The cooling times were then recalculated for a cask containing 24 original design basis fuel assemblies loaded with 24 design basis BPRAs. The calculated increase in surface dose rate resulting from the addition of BPRAs remains within the bounds of the previous analysis. The applicant also provided data showing that few BPRAs are irradiated for more than one cycle. Loading 24 design basis BPRAs in a single cask is not probable, therefore, the calculated dose rates are conservative.

The staff confirmed the applicant's conclusion by reviewing the submitted calculations. Additionally, an independent review was conducted by generating source terms for the B&W 15x15 BPRA using SAS2H from the SCALE 4.4 suite of computer codes. The staff's analysis agreed with the applicant's conclusions. The BPRAs are limited to maximum burnups and minimum cooling times as shown in Table 1-2c of the revised Technical Specifications. Based on the confirmatory review of the information provided by the applicant, the staff has reasonable assurance that the NUHOMS®-24P will continue to meet the shielding requirements of 10 CFR Part 72.

## 5.0 CRITICALITY

The applicant performed analyses to determine the effect of including BPRAs with the B&W 15x15 Mark B and Westinghouse 17x17 (Standard and OFA) PWR fuel assemblies in the NUHOMS®-24P DSC. For criticality control, the casks are filled with borated water during loading and unloading, and the BPRA rods displace the borated water. Calculations were performed with the CSAS26 code and 44-group neutron cross section in the SCALE suite of codes.

The applicant modeled an infinite array of fuel assemblies with guide sleeves in a typical basket pitch and found that for water densities from 0 to 0.85 g/cc, the fuel assemblies are less reactive with BPRAs inserted than without. For the water densities from 0.85 to 1 g/cc, $k_{eff}$ increases slightly when BPRAs are inserted. For this upper range of water densities, the applicant modeled an infinitely long cask reflected by 12 inches of borated water surrounded by an infinite layer of fresh water. In both models described above, the BPRAs were represented by filling the inside of the fuel assembly guide and instrument tubes with $^{11}B_4C$. This simulated the presence of the BPRAs without taking credit for any unburned $^{10}B$.

The results of the applicant's analyses show that for water densities from 0 to 0.85 g/cc, the addition of BPRAs causes the reactivity of the fuel assemblies to be less than the previously approved fuel assemblies without BPRAs. For water densities from 0.85 to 1 g/cc, the results of the cask model calculations when the BPRAs are included gave a peak $k_{eff}$ of 0.9203 which is less than the maximum $k_{eff}$ in the previous application. Since the cask model had used nominal mechanical tolerances and fuel assembly positions in the basket, the applicant also performed a calculation with the tolerances and positions at the values which maximized $k_{eff}$. This calculation was at the point of maximum $k_{eff}$ for the nominal cask model and gave a $k_{eff}$ value below 0.95 when adjusted for bias and uncertainty.

The staff reviewed the applicant's analyses and methods and performed independent calculations. The independent calculations agree with the trends in the analysis. Since the

applicant modeled the fuel rods as dry in the pellet-to-clad gap rather than being flooded, the staff's calculations included cases to assess this assumption. Staff results found that reactivity is maximized when the gap is dry.

Based on its review of the statements and representations in the application and on its independent calculations, the staff has reasonable assurance that the proposed amendment meets the criticality safety requirements of 10 CFR Part 72.

**CONCLUSIONS**

The staff performed a detailed safety evaluation of the proposed Certificate of Compliance amendment request and found that the addition of the BPRAs to the B&W 15x15 and Westinghouse 17x17 fuel assembly types does not reduce the safety margin. In addition, the staff has determined that the storage of BPRAs in the NUHOMS®-24P storage system does not pose any increased risk to public health and safety. The remaining areas of review addressed in NUREG 1536,"Standard Review Plan for Dry Cask Storage Systems," January 1997, are not affected by the applicant's amendment request. Based on the statements and representations contained in the applicant's SAR and the conditions in the Certificate of Compliance, the staff concludes that the addition of BPRAs to the B&W 15x15 and Westinghouse 17x17 fuel assembly types to the authorized contents of the NUHOMS®-24P storage system meets the requirements of 10 CFR Part 72.

**References**

1. Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, Revision 4A, NUH003.0103, June 1996.
2. Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUHOMS 24-P, NUH002.0103, Revision 2A, April 1991.
3. Nonfuel Assembly Database, Notz. K.J., and Moore, R.S., DOE, Chattanooga, TN.
4. Revision 1 of the Application for Amendment No. 3 of NUHOMS® CoC No. 1004 for Dry Spent Fuel Storage Casks, November 29, 1999.
5. Application for Amendment No. 3 of NUHOMS® CoC No. 1004 for Dry Spent Fuel Storage Casks, July 26, 1999.