UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FINAL SAFETY EVALUATION REPORT
NAC INTERNATIONAL
NAC-UMS® STORAGE SYSTEM
DOCKET NO. 72-1015
AMENDMENT NO. 9

Summary

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of amendment No. 9 to Certificate of Compliance No. 1015 for the Model No. NAC-UMS® spent nuclear fuel (SNF) storage system. On July 30, 2021 (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML21222A017), NAC International (NAC or the applicant) submitted a request to the NRC in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 72.244 to amend Certificate of Compliance No. 1015.

NAC did not request any technical changes to the certificate or technical specifications other than incrementing the revision number. NAC requested correction of effective thermal properties for pressurized-water reactor (PWR) fuel assemblies used in the certification basis ANSYS thermal models and it updated some modeling assumptions. NAC previously reported the errors associated with the effective thermal conductivities by letter dated March 4, 2021 (ADAMS Accession No. ML21070A324). NAC incorporated the changes to the thermal analysis in Chapter 4, "Thermal Evaluation," and revised chapter 11, "Accident Analyses" to update the storage system temperatures. No other chapters of the safety analysis report (SAR) were revised with this amendment.

In support of the amendment, NAC submitted Revision 21A of the SAR for the NAC-UMS® storage system. The NRC staff reviewed the amendment request using guidance in NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities", dated April 2020. After completing its review of the statements and representations in the application and the conditions specified in the certificate of compliance and technical specifications, the NRC staff concludes that with the requested changes, the NAC-UMS® storage system meets the requirements in 10 CFR Part 72.

Chapter 4 THERMAL EVALUATION

The objective of the review is to verify that the thermal performance of the NAC-UMS® storage cask design satisfies the thermal requirements in 10 CFR Part 72.

Within this certificate amendment request, the applicant revised its thermal evaluations for off-normal, transfer, and accident conditions to correct the effective thermal properties for PWR fuel assemblies used in the certificate technical basis in the ANSYS thermal models and updated some of the modeling assumptions. In addressing the correction to the effective thermal properties, NAC corrected the pellet diameter from the larger diameter of the fuel rod to the pellet's smaller, appropriate, and actual diameter, which impacted the thermal analysis due to the excess thermal mass. As stated in the March 4, 2021 report, the error in calculating the fuel assembly effective thermal conductivity only affected time dependent (transient analyses) and not steady state conditions, such as normal conditions.

NAC provided Calculation Package Nos. EA790-3006, Revision 1, “UMS - Design, Analysis and Licensing,” EA790-3206, Revision 5, “UMS - PWR Storage Canister Thermal Analysis,” and EA790-3506, Revision 7, “Thermal Analyses for UMS Transfer Cask/Canister for PWR Fuel,” were revised and provided in the application for NRC review. The applicant provided the new temperature results and modeling assumptions in the updated SAR. In addition, the applicant stated, and the NRC verified, that the revised analyses results did not exceed thermal limits or alter any operational time limits. The applicant used the ANSYS finite element computer code to generate their new temperature results.

NAC’s revised modeling assumptions include:

1) Modeling the shortest associated canister and transfer cask to maximize the contents heat generation rate per volume and minimize the heat rejection from the external surfaces for PWR fuel types,
2) Adjusting the effective thermal conductivities in the fuel and water regions based on classical energy balance calculations of the canister contents while taking natural circulation of the water into account when the canister is filled with water at the beginning of the transfer operation for the PWR configuration analysis,
3) Applying the volumetric heat generation to the active fuel region based on a total heat load of 23 kW for PWR fuel,
4) Applying the thermal conductivity of air for the media inside the canister during the vacuum drying condition for the PWR model,
5) Modeling the PWR model as shown in Figure 4.4.1.6-1 of the SAR submitted for approval that included the fuel tube, the BORAL plate (including a core matrix sandwiched by aluminum cladding), stainless steel cladding and a gap between the stainless-steel cladding and the support disk or heat transfer disk, and
6) Considering the use of helium, water, vacuum, and saturated steam as the media in the gaps mentioned in item 5, immediately above.

The NRC staff evaluated these modeling assumptions and determined that they were acceptable because they are consistent with the information presented in NUREG-2215, acceptable engineering practice, and represent a conservative representation of the actual configuration.

After reviewing the assumptions listed above, their importance in the modeling and how they impacted the temperature results listed in the SAR, the NRC staff has reasonable assurance that, although the temperature values did increase when used the thermal analyses resulted in temperatures that are below the temperature limits for all storage system components and the peak clad temperature for all fuel assemblies.

Within this application, in addition to conductive heat transfer, the applicant takes credit for convection and radiation heat transfer. In section 4.4.1.3 of the SAR, the applicant states that convection is considered at the top of the canister lid, the exterior surfaces of the transfer cask, as well as at the annulus between the canister and the inner surface of the transfer cask. The combination of radiation and convection heat transfer at the transfer cask exterior vertical surfaces and canister lid top surface is considered in the model using the same method described in section 4.4.1.2 of the SAR for the three-dimensional canister models.

After reviewing the discussion on heat transfer within the models, reviewing the calculation packages that generated the results, staff finds the discussion on the heat transfer within this model acceptable, because the temperatures for off-normal and accident conditions remain below the temperature limits for all storage system components and the peak clad temperature.

The applicant provided the following where the corrected effective thermal properties (listed in tables 4.4.1.2-1 for PWR Fuel Assemblies) were used in their revised thermal analyses:

- Table 4.1.4, “Summary of Thermal Evaluation Results for the Universal Storage System: PWR Fuel,” showing changes in the calculated values for various parts of the cask during off-normal conditions, accident conditions (extreme heat), and transfer conditions (vacuum drying and backfilled with helium),
- Table 4.4.3-3, “Maximum Component Temperatures for the Transfer Condition – PWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load,”
- Table 4.4.3-5, “Maximum Limiting Component Temperatures in Transient Operations for the Reduced Heat Load Cases for PWR Fuel,”
- Table 4.4.3-6, “Maximum Limiting Component Temperatures in Transient Operations for the Reduced Heat Load Cases for PWR Fuel after In-Pool Cooling,”
- Table 4.4.3-7, “Maximum Limiting Component Temperatures in Transient Operations for the Reduced Heat Load Cases for PWR Fuel after Forced-Air Cooling,”
- Table 4.4.3-13, “Maximum Limiting Component Temperatures in Transient Operations after Helium for PWR Fuel after In-Pool Cooling,”
- Table 4.4.3-14, “Maximum Limiting Component Temperatures in Transient Operations after Helium for PWR Fuel after Forced-Air Cooling,” and

In addition, NAC updated the temperatures in section 11.2.7.3 of the SAR where it displays a table with the components, their calculated temperatures at 133°F ambient and the allowable temperatures for PWR fuel configurations.

After reviewing the information provided in the tables, sections, and results in the SAR, verifying the effective thermal conductivities through the acceptable engineering references, and reviewing the calculation packages that generated these temperature results, staff finds the spent fuel cladding will be protected against gross rupture and that cask component temperatures are all below their maximum temperature limits for off-normal and accident conditions and, therefore the NAC-UMS® storage system is in compliance with 10 CFR Part 72.

Chapter 13 TECHNICAL SPECIFICATIONS

While there were no changes to the technical specifications for this amendment, the NRC made minor editorial changes to the technical specifications. In both appendix A and appendix B, the NRC deleted the list of effective changes since both appendices are published in full for each amendment. The NRC added “Appendix A” to the top of the table of contents page, consistent with the table of contents for appendix B.

CONCLUSION

The NRC staff performed a detailed safety evaluation of the application for amendment No. 9 to Certificate of Compliance No. 1015 for the NAC-UMS® storage system. The NRC staff performed the review in accordance with the guidance in NUREG-2215, “Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities.” Based on the statements and representations contained in the application and the conditions established in the certificate of compliance and its technical specifications, the NRC staff concludes that these changes do not affect the ability of the NAC-UMS® storage system to meet the requirements of 10 CFR Part 72 and that the NAC-UMS® storage system provides reasonable assurance of adequate protection of public health and safety and protects the environment.

Issued with Certificate of Compliance No. 1015, amendment No. 9,
on July 22, 2022

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