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

PRELIMINARY SAFETY EVALUATION REPORT
NAC INTERNATIONAL
NAC-MPC STORAGE SYSTEM
DOCKET NO. 72-1025
AMENDMENT NO. 7

Summary

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of Amendment No. 7 to Certificate of Compliance (CoC) No. 1025 for the Model No. NAC-MPC spent fuel storage system. By application dated November 14, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17326A128), as supplemented on February 12, 2018 (ADAMS Accession No. ML18045A440), 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 CoC No. 1025. NAC demonstrated, as discussed in Section 4.0 of this SER that with a reduced heat load from 4.5 to 2.8 kW, the convective heat flow in the annulus between the canister and concrete cask does not need to work in order for the storage cask and spent fuel to remain below their respective maximum operating temperatures. Therefore, NAC requested the following changes to the technical specifications (TS) to eliminate the requirements for the heat removal system to be operable and to eliminate duplicative requirement:

- Modify the definition for OPERABLE under TS A 1.1, "Definitions" deleting reference to Multi-Purpose Canister – La Crosse Boiling Water Reactor (MPC-LACBWR);
- Revise the note under ACTIONS of TS Limiting Condition for Operation (LCO) 3.1.6 under TS A 3.1.6, "CONCRETE CASK Heat Removal System" to include that LCO 3.1.6 is not applicable to the MPC-LACBWR CANISTER. Revise SURVEILLANCE under Surveillance Requirement (SR) 3.1.6.1 by deleting "and the MPC-LACBWR CANISTER." Further, add a footnote SR 3.1.6.1 stating, "SR 3.1.6.1 is not applicable to the MPC-LACBWR CANISTER. Convective cooling is not required for the MPC-LACBWR CANISTER;" and
- Revise TS A 5.3 under A 5.0, "ADMINISTRATIVE CONTROLS AND PROGRAMS" to delete the requirement for a response surveillance following off-normal, accident or natural phenomena events since it is, in principle, covered by existing LCO SRs and frequencies.

In addition, the staff made the following TS changes to maintain consistency with the applicant's proposed change for the decay heat and an editorial change to be consistent within TS 3.1.2:

- Based on new analysis, reduced the original licensing basis heat load from 4.5 kW to 2.8 kW in Appendix A of the CoC in item 1.c of TS LCO 3.1.1. Further, added Foot Note No. 6, "Maximum CANISTER decay heat ≤ 2.8 kW," to Table B2-8 for "Heat Load (watts)" in Appendix B of the CoC.

- TS LCO 3.1.2 in Appendix A of the CoC was revised from "----below 10 torr----" to "----at or below 10 torr----," to maintain consistency with the NOTE under "ACTIONS," which is considered as an administrative change.

In support of the amendment, NAC submitted Revision 18A, of the final safety analysis report (FSAR) for the NAC-MPC storage system, and made the following changes to the FSAR:

- In Chapter 4 of the FSAR, add a new Section 4.A.4, "Thermal Evaluation of MPC-LACBWR with a Heat Load of 2.8 kW."
- In Chapter 4 of the FSAR, move reference section from 4.A.4 to Section 4.A.5.
- In Chapter 9 of the FSAR, revise Sections 9.2 and 9.A.3.1 to remove the unnecessary response surveillance and reference to Section A.5.3.
- In Chapter 9, Section 9.A.3.1 of the FSAR, add a bullet to the top of Page 9.A.3-2, to visually inspect the inlet and outlet screens as part of the annual maintenance program.
- In Chapter 12, Page 12C3-19 of the FSAR, revise the LCO Bases 3.1.6 and SR 3.1.6.1 removing MPC-LACBWR from the applicability actions, and SRs sections. Further, revise A.1 to provide additional guidance for the intent of "immediate" actions (i.e., in the context of restoring the heat removal capabilities of the concrete cask).
- Revise MPC-LACBWR drawing listed in Chapter 1 of the FSAR, implementing a finer mesh inlet and outlet vent screen. In Chapter 3, Section 3.A.4.4.3.3 of the FSAR, correct a typo in the first paragraph, and add a second paragraph describing MPC-LACBWR evaluation with heat loads of 2.8 kilo watts (kW) and no air flow in the cask annulus.

The NRC staff reviewed the amendment request using guidance in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," Rev. 1, dated July 2010. For the reasons stated below, and based on its review of the statements and representations in the application, as supplemented, and the conditions specified in the CoC and TS, the staff concludes that the requested changes meet the requirements of 10 CFR Part 72.

The NRC staff determined that the following areas of review are not affected by this amendment and therefore are not addressed in this SER: general description, principal design criteria, structural, confinement, shielding, criticality, materials, operating procedures, acceptance tests and maintenance program, radiation protection, accident analyses, and quality assurance.

4.0 Thermal Evaluation

The NRC staff reviewed the proposed Amendment No. 7 changes to the MPC-LACBWR to ensure that the applicant had performed adequate thermal evaluation to demonstrate the system compliance with 10 CFR Part 72. NRC evaluated the following changes to the thermal evaluation in the FSAR.

(a) Requirement for Cask Cooling to Remain Operable

The applicant stated in this amendment application that MPC-LACBWR cask and spent fuel would not exceed its allowable temperature limits during all storage conditions. Therefore, in an effort to eliminate the need for daily surveillances that verify the concrete cask heat removal system is operable for the MPC-LACBWR by performing visual inspections of the concrete overpack inlet/outlet vents or remote temperature monitoring of the concrete overpack outlet vents, the applicant revised the following:

i. the original thermal evaluation by reducing the original licensing basis heat load of 4.5 kW to a heat load of 2.8 kW to accurately reflect the concrete overpack temperatures and assure that they still remain below allowable limits for all storage conditions, and

ii. LCO 3.1.6 by adding the condition “LCO 3.1.6 is not applicable to the MPC-LACBWR canister.” and revised SR 3.1.6.1 by adding a note, “SR 3.1.6.1 is not applicable to the MPC-LACBWR canister. Convective cooling is not required for the MPC-LACBWR canister.”

The staff reviewed the revised thermal evaluation provided in Calculation No. 63004500-3001, Rev. 3 (Enclosure 4 in this amendment application). The staff reviewed Calculation No. 63004500-3001 Rev. 3 and summarized the review below.

(b) FSAR License Drawing No. 630045-866, Revision 4.

The applicant proposed to add 18” x 18” x.02” woven wire cloth as an approved alternate for the screen material and requested a change to the MPC-LACBWR licensing drawing that details the screen mesh size for the concrete overpack (Licensing Drawing 630045-866, Rev. 4).

The applicant stated in NAC-MPC FSAR Amendment No. 7 that the previous 4” x 4” x .032” wire mesh has 76% open area, versus the 18” x 18” x.02” having 41% open area and the reduced open area of the 18” x 18” x .02” woven wire cloth provides greater control against debris entering the inlet while increasing restriction to airflow through the inlet vents and into the annulus. The applicant stated in Calculation No. 63004500-3001 Rev. 3 that no annulus airflow is assumed to establish a bounding condition for steady state thermal analyses. Therefore, the reduced open area of the 18” x 18” x .02” woven wire cloth is enveloped by the thermal evaluation.

The staff reviewed the description of 18” x 18” x.02” wire cloth proposed for use in MPC-LACBWR and Licensing Drawing No. 630045-866, Rev. 4 for inlet screen and outlet screen located at concrete overpack. The staff accepts the proposed change because it has no significant impact to the heat removal system of MPC-LACBWR.

4.1 Thermal Model

The applicant described the thermal model in Calculation No. 63004500-3001 Rev. 3 of the application. The applicant used ANSYS (Rev. 10) to construct a three-dimensional finite-element model with one-quarter symmetry of MPC-LACBWR loaded canister including fuel assembly, fuel basket, and concrete cask. The applicant’s model includes the features below:

a) Each fuel assembly is modeled as a homogeneous region with effective orthotropic thermal properties, and each side of each fuel tube is also modeled as a homogeneous region with effective orthotropic thermal properties. Helium is the media in the effective property calculation.

b) The quarter of the basket with the least Boral plates is modeled, as explained in Appendix F of Calculation No. 63004500-3001 Rev. 3.

c) No air is modeled in the annulus (No convection heat transfer in annulus). Heat transfer mode from the canister to the concrete cask is radiation.

d) Convection, radiation, and solar insolation are applied to the concrete top and side surfaces.

e) The ambient temperature for each condition (normal, off-normal and accident-level conditions) is applied to the concrete bottom surface, while the bottom surface of the canister bottom plate is assumed to be adiabatic.

The staff reviewed the description of the thermal model in Calculation No. 63004500-3001, Rev. 3 and confirmed that the applicant's thermal model is acceptable because the thermal features in the model are appropriate per staff's engineering justification and the model approach used in this amendment application is consistent with the approach used for other NAC-MPC models that have been reviewed and approved by the NRC.

4.2 Material Properties

The applicant specified in Appendix E of Calculation No. 63004500-3001 Rev. 3 that the ANSYS code is used to determine the effective thermal properties for MPC-LACBWR fuel assemblies for the following: (a) effective conductivities of the fuel assemblies in the transverse direction are determined based on the heat load and ΔT from the center of the fuel assembly to the edge of the model, as well as the fuel dimension; and (b) effective conductivities in the axial direction of the fuel assemblies, the effective density and effective specific heat are calculated based on weighted cross-section areas, volume and mass, respectively.

The staff reviewed Appendix E of the calculation and accepts the approach of effective thermal properties for the fuel assemblies loaded in MPC-LACBWR because the approach is consistent with those previously approved by the NRC and are therefore, acceptable for this amendment application.

4.3 Normal, Off-Normal and Accident-level Conditions of Storage

The applicant stated in Calculation No. 63004500-3001 Rev. 3 that steady-state thermal analyses were performed for MPC-LACBWR under normal, off-normal, accident-level conditions of storage, with a heat load of 4.5 kW, no convection in overpack annulus and no thermal conduction by air in the annulus and in the zone between the canister top and vertical concrete cask (VCC) top. The applicant described the thermal conditions of normal, off-normal and accident-level storage in Section 1.0 and Table 4 and summarized the results of these analyses in Table 5 of Calculation No. 63004500-3001 Rev. 3. The applicant stated that the maximum temperatures of the MPC-LACBWR fuel assemblies, fuel basket, and canister remain below the allowable temperatures for long-term (normal) and short-term (off-normal and accident) storage conditions.

The staff reviewed Table 4 and Table 5 of Calculation No. 63004500-3001 Rev. 3 and confirmed that (a) the peak cladding temperatures (PCTs) are below the limits of 752 °Fahrenheit (F) under normal conditions and 1058 °F under off-normal and accident conditions and (b) the maximum cask component temperatures are maintained below the allowable limits with sufficient margins for all conditions.

The applicant stated in Section 4.A.4 of the FSAR that an additional thermal evaluation was performed for the MPC-LACBWR with a heat load of 2.8 kW and the calculated maximum concrete temperatures are provided in Section 4.A.4 of the FSAR.

The staff reviewed FSAR Section 4.A.4 and supporting Calculation No. 63004500-3001 Rev. 3 and determined that the thermal analysis for the MPC-LACBWR under normal, off-normal and accident-level conditions of storage is acceptable because it's consistent with the provisions of SFST-ISG-11, Revision 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel," and the PCT and maximum cask component temperatures are below the allowable limits with sufficient margins for all storage conditions.

4.4 Evaluation for 50% Compaction of Damaged Fuel (off-normal)

The applicant stated in Appendix G of Calculation No. 63004500-3001 Rev. 3 that the case for 50% compaction of damaged fuel, positioned at the mid-height of the fuel basket, was evaluated. The applicant applied the heat generation of 4.5 kW from the damaged fuel assembly over the length of the compacted fuel region and modified the remainder of the fuel assembly length to have the properties of helium in the thermal model. Radiation through the helium is not accounted in the thermal evaluation. The applicant presented the maximum fuel cladding and component temperatures in Table G.1 for normal, off-normal, and accident-level conditions of storage.

The staff reviewed Appendix G and Table G.1 and accepts thermal evaluation for 50% compaction of damaged fuel because (a) the assumptions and thermal features applied to the thermal model are appropriate per staff's engineering justification on the heat load distribution and (b) the maximum fuel cladding and component temperatures shown in Table G.1 are below their corresponding limits with good margins under normal, off-normal, and accident-level conditions of storage.

4.5 Evaluation of Fire Accident Condition

The applicant stated in Appendix H of Calculation No. 63004500-3001 Rev. 3 that (1) the fuel heat applied to the model is 4.5 kW with a peaking factor 1.406 for the power profile, (2) a convection film coefficient and an emissivity of 0.9 are used for the 30-minute fire, (3) the initial conditions are obtained from steady state case with solar insolation, and (4) the duration of the fire is 30 minutes with fire temperature of 1475 ˚F and no insolation, and (5) the post-fire cool down has an ambient temperature of 75 ˚F and solar insolation.

The staff reviewed Appendix H of Calculation No. 63004500-3001 Rev. 3 and accepts the applicant's thermal evaluation of fire accident condition because the heat load of 4.5 kW and a fire duration of 30 minutes used in the model are conservative and both PCT and maximum cask component temperatures remain below the required temperature limits.

4.6 Evaluation of Concrete Temperatures

The applicant stated in Appendix I of Calculation No. 63004500-3001 Rev. 3 that the view factor of 1.0 is used at VCC for analysis presented in Appendix I (2.8 kW) for this amendment application since there are only five casks on the pad as shown in Figure I-1 of Appendix I. The applicant calculated maximum concrete temperatures, average concrete temperatures, and through-wall temperature differences in Tables I.2-1, I.2-2, and I.2-3 of Appendix I for normal, off-normal – cold, off-normal – hot, and accident-level conditions.

The staff reviewed Figure I-1 in Appendix I of the calculation, and finds that use of a view factor of 1.0 is appropriate for thermal evaluation because there are only five casks remained on the pad.

The staff reviewed Appendix I and Tables of I.2-1, I,2-2, and I.2-3 of the Calculation, and finds that (a) the maximum concrete temperatures are below allowable limits of 200 ˚F for normal conditions and 350 ˚F for off-normal and accident conditions and (b) the average concrete temperatures are below allowable limits of 150 ˚F for normal conditions and 350 ˚F for off-normal and accident conditions. The staff also finds that the calculated through-wall-differences (based on a heat load of 2.8 kW) in Appendix I are acceptable because they are below the calculated through-wall-differences (based on a heat load of 4.5 kW) as shown in NAC Calculation No. 12414-2007, Rev. 1, "Connecticut Yankee VCC Structural Analysis," which was reviewed and accepted by NRC.

4.7 Evaluation Findings

F4.1 The staff has reasonable assurance that the MPC-LACBWR (with a heat load up to 2.8 kW) continues its heat-removal capability having verifiability and reliability consistent with its importance to safety.

F4.2 The staff has reasonable assurance that the fuel cladding in the MPC-LACBWR (with a heat load up to 2.8 kW) continues to be protected against degradation leading to gross ruptures by maintaining the cladding temperatures below 400 °C (752 °F) for short-term operations and normal conditions of storage and 570 °C (1058 °F) for off-normal and accident conditions of storage, and other cask component temperatures continue to be maintained below the allowable limits for the accidents evaluated.

F4.3 Based on the evaluations and findings above, the staff has reasonable assurance that (a) the proposed changes to LCO 3.1.6 and SR 3.1.6.1 in CoC Appendix A are acceptable and (b) an annual inspection of inlet and outlet vents are incorporated and required, as described in the annual maintenance chapter of NAC-MPC System FSAR, in order to verify the vents are not obstructed.

13.0 Technical Specifications Evaluation

The changes to TS, Appendix A, listed below were evaluated in Section 4.0 of this SER.

- Definition for OPERABLE under TS A 1.1 was modified deleting reference to MPC-LACBWR;
- Note under ACTIONS of TS LCO 3.1.6 was revised to include that LCO 3.1.6 is not applicable to the MPC-LACBWR CANISTER. Further, a footnote was added to TS SR 3.1.6.1 stating, "SR 3.1.6.1 is not applicable to the MPC-LACBWR CANISTER. Convective cooling is not required for the MPC-LACBWR CANISTER;"
- TS A 5.3 was revised to delete the requirement for a response surveillance following off-normal, accident or natural phenomena events;
- Item 1.c of TS LCO 3.1.1 has been revised from the original licensing basis heat load of 4.5 kW to 2.8 kW to keep the concrete overpack temperatures below the allowable limits for all storage conditions;
- Foot Note No. 6, "Maximum CANISTER decay heat ≤ 2.8 kW," was added to Table B2-8 for "Heat Load (watts)" in Appendix B of the CoC; and
- TS LCO 3.1.2 was revised from "----below 10 torr----" to "----at or below 10 torr----," to maintain consistency with the NOTE under "ACTIONS."

Changes in TS LCOs 3.1.1 and 3.1.6 in Appendix A of the CoC, and Table B2-8 in Appendix B of the CoC were evaluated in Section 4.0 of this SER. Definition for OPERABLE under TS A 1.1 was revised reflecting the changes to TS SR 3.1.6.1.

TS LCO 3.1.2 was revised to be in concurrence with the NOTE under LCO 3.1.2, and this revision is considered as an administrative change. TS A 5.3 was revised to avoid duplication because the change was covered by existing LCO SRs and frequencies.

13.1 Evaluation Findings

F13.1 The staff concludes that the conditions for use of the NAC-MPC storage system identify necessary technical specifications to satisfy 10 CFR Part 72 and that the applicable acceptance criteria have been satisfied. The proposed technical specifications provide reasonable assurance that the storage system will allow safe storage of spent fuel. This finding is based on the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

CONCLUSION

The staff performed a detailed safety evaluation of the application for Amendment No. 7 to CoC No. 1025 for the NAC-MPC storage system. The staff performed the review in accordance with the guidance in NUREG-1536. Based on the statements and representations contained in the application, as supplemented, and the conditions established in the CoC and its TS, the staff concludes that these changes do not affect the ability of the NAC-MPC storage system to meet the requirements of 10 CFR Part 72.

Issued with CoC No. 1025, Amendment No. 7, on draft