# NAC INTERNATIONAL, INC.

# NAC MULTI-PURPOSE CANISTER (NAC-MPC) SYSTEM

# SAFETY EVALUATION REPORT

# AMENDMENT NO. 4

## SAFETY EVALUATION REPORT

Docket No. 72-1025
NAC-MPC STORAGE SYSTEM
Certificate of Compliance No. 1025
Amendment No. 4

### SUMMARY

By application dated August 1, 2003, as supplemented on September 5, 2003, and November 5, 2003, NAC International, Inc. (NAC) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subparts K and L, to Certificate of Compliance (CoC) No. 1025 for the Multi-Purpose Canister (MPC) storage system.

NAC requested changes to the CoC, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The requested changes were to: (1) increase vacuum drying time limits; (2) increase canister in transfer cask time limits; (3) revise fuel cooldown requirements; (4) delete canister removal from concrete cask requirements; (5) revise surface contamination removal time limits; and (6) revise allowable contents fuel assembly limits.

The Nuclear Regulatory Commission (NRC) staff has reviewed the application using the guidance provided in NUREG-1536, “Standard Review Plan for Dry Cask Storage Systems.” Based on the statements and representations in the application, as supplemented, the staff concludes that the NAC-MPC system, as amended, meets the requirements of 10 CFR Part 72. The changes to the CoC are indicated by change bars in the margins.

### BACKGROUND

The NAC-MPC system consists of the following components: (1) transportable storage canister (TSC), which contains the spent fuel; (2) vertical concrete cask (VCC), which contains the TSC during storage; and (3) a transfer cask, which contains the TSC during loading, unloading and transfer operations. Each TSC stores up to 36 fuel assemblies from the Yankee Nuclear Power Plant (Yankee Rowe) or up to 26 fuel assemblies from Connecticut Yankee Atomic Power Company (Haddam Neck), both decommissioned pressurized water reactors (PWRs).

The NAC-MPC was originally approved for storage of spent fuel from the Yankee Rowe plant. Amendment No. 1 revised the CoC to allow an alternate fuel basket design, increase canister loading operational time limits, and increase canister surface contamination limits. Amendment No. 2 to the NAC-MPC CoC added Haddam Neck (CY) spent fuel to the authorized contents of the NAC-MPC system. Amendment No. 2 also revised the CoC format for consistency and revised CoC Appendix A, Technical Specifications (TS) and Appendix B, Approved Contents and Design Features in its entirety to address the addition of CY fuel. Amendment No. 3 revised the CoC to incorporate Yankee Class parameters, damaged fuel cans, recaged assemblies, and to correct CY fuel parameters.

## STRUCTURAL EVALUATION

This section provides the structural evaluation of the NAC-MPC design change that resulted in an increased weight in the TSC, the potential for thermal stresses in the transfer cask doors, and the potential for transfer cask tip-over due to tilting during vacuum drying operations.

The applicant evaluated the potential impact of additional weight added to the TSC from the insertion of solid stainless steel rods into the Reactor Control Cluster Assembly (RCCA) guide tubes to displace residual water. The staff evaluated the applicant's analysis which demonstrated that the addition of the stainless steel rods does not exceed the previously approved canister weight limit of 35,100 lbs.

Section 3.4.4.7.2 of the Safety Analysis Report (SAR) provided calculations of thermal stresses in the transfer cask doors. The staff evaluated the applicant's analysis which concluded that the use of up to a 15 kW heater under the transfer cask doors during the drying process would have no adverse effect on the structural performance of the doors.

SAR Section 3.4.3.8 provided calculations to support allowing the transfer cask to be tilted to enhance vacuum drying during draining operations. The calculations support a maximum $6^{o}$ transfer cask tilt which would result in an 8.1-inch lateral displacement of the center of gravity. Additionally, the tilt would result in 10% of the loaded transfer cask weight being applied in a direction parallel to the surface upon which it rests. This corresponds to static stability margins of 7.0 and 5.2 against sliding and overturning motions, respectively.

On the basis of the evaluations above, the staff agrees that the proposed changes do not adversely affect the ability of the system to meet the structural performance requirements of 10 CFR Part 72.

## MATERIALS EVALUATION

This section provides the materials evaluation of the NAC-MPC design change associated with NAC's adoption of the acceptance limits specified in Interim Staff Guidance No. 11 (ISG-11), Revision 2, "Cladding Considerations for the Transportation and Storage of Spent Fuel."

The applicant indicated that most of the CY spent fuel has stainless steel cladding and that the temperature limits for normal conditions of storage, short-term operations, and for accident and off-normal operations have been previously approved by staff. The staff has determined that hydride reorientation is a phenomenon that occurs in zirconium-based fuel cladding materials and will not occur in stainless steel fuel cladding; therefore, this phenomenon does not need to be addressed for stainless steel cladding. ISG-11, Revision 2, established a maximum allowable cladding temperature limit of 400EC (752EF) for normal conditions of storage and for short term operations, including cask drying and backfilling. The staff issued ISG-11, Revision 3, on November 17, 2003, to clarify some acceptance criteria provided in Revision 2 and to add criteria allowing higher cladding temperature limits for low burnup fuel and additional information on thermal cycling. The staff evaluated the applicant's amendment against the new ISG criteria to determine if it met the following acceptance criteria: (1) a cladding temperature limit of 400EC for normal conditions of storage and short-term loading operations, (2) minimizing thermal cycling, and (3) a cladding temperature limit of 570EC for accident and off-normal operations.

SAR Tables 4.5.3-7 and 4.5.3-9 show that the temperature limits of 400EC are not exceeded for the low burnup fuel cladding. Thus, the staff concludes that based on the temperature limits in the SAR tables for short-term operations, cladding hoop stresses for low burnup fuel will be below 90 MPa, during normal conditions of storage and short-term loading operations. Hydride re-precipitation will not occur in the cladding as a result of thermal cycling, because very little to no hydrogen goes into solution at the temperatures experienced during short-term operations for the spent fuel evaluated as part of this application. The staff determined that there was no need to impose the thermal cycling criteria on low burnup fuel because; (1) the hoop stresses in the cladding will be below 90 MPa, (2) the cladding temperatures are below 400EC, and (3) there is no available hydrogen to go into solution at the temperatures calculated for short-term operations. The temperature limit of 570EC for low burnup zircaloy during off-normal and accident conditions are consistent with staff guidance.

The staff determined that inserting solid stainless steel rods into the fuel assemblies to displace water has no impact on the material’s performance. Additionally, applying low temperature heat to the bottom of the transfer cask shield door has no adverse impact on the stainless steel cask body exterior.

The staff agrees that the proposed changes do not adversely affect the ability of the system to meet the material performance requirements of 10 CFR Part 72.

**THERMAL EVALUATION**

This section provides the thermal evaluation of the NAC-MPC design associated with increasing the maximum time permitted for vacuum drying, adding stainless steel rods into the RCCA guide tubes, and adding external heat to the transfer cask doors.

The applicant stated that the addition of 21-inch stainless steel rods into the RCCA guide tubes to displace residual water in the guide tube dash pots has a negligible effect on the maximum temperatures of the fuel and basket components. The applicant also stated that the use of a 200EF heated pad at the bottom surface of the transfer cask shield door, to aid in water evaporation during the vacuum drying stage, has a negligible effect on the maximum temperatures of the fuel and basket components. The staff agrees with these statements since the changes are applied to the bottom region of the cask where there is minimal internal generation of heat.

In addition to the changes described above, the applicant requested an increase in the maximum time permitted for vacuum drying. Since the issuance of Amendment No. 2, the applicant has revised the maximum time allowed for the water-filled condition under the provisions of 10 CFR 72.48. The applicant’s evaluation, using the 72.48 change process, calculated canister component temperatures (including the fuel cladding) at the onset of the vacuum drying process with lower values than those approved in Amendment No. 2. The staff did not review the applicant’s 72.48 evaluation, but instead used the lower temperatures as part of the basis for the technical review of the adequacy of this amendment request.

The applicant changed the basis of the vacuum drying process to assume the presence of vapor inside the canister during the first 4 hours. The same 3-D ANSYS model adopted in Amendment No. 2 was used; however, the initial lower internal temperatures together with a temporarily better conducting medium (vapor conducts better than vacuum), yields longer allowable operating times than that approved in Amendment No. 2. The process was simulated until one of the component materials was near its allowable temperature limit. In order to account for operation time, the Technical Specifications (TS) LCO 3.1.1 time limit for vacuum drying is 2 hours less than the calculated time.

In the event that the vacuum drying process is not successful, the canister must be filled with Helium and cooled for at least 24 hours under two possible scenarios: (1) placed back into the spent fuel pool, or (2) cooled by forced air. This allows the internal temperatures to come down before another vacuum drying process is attempted. For the forced air condition (maximum air temperature of 75EF at a minimum rate of 375 CFM), the applicant revised the convection correlation for air forced into an annulus. With this one exception, the same 3-D ANSYS model was used in Amendment No. 2.

After the 24 hour cooling period, a second vacuum drying process can be performed. Unlike the initial vacuum drying evaluation, no vapor is assumed inside the canister. Once again, the time limits obtained from the 3-D ANSYS calculations (for the different heat loads) are decreased by 2 hours in the TS, to account for operation time.

When the vacuum drying process is successful, the canister is backfilled with Helium. The applicant provided calculations that supported the internal temperatures not reaching any of the allowable limits even if the canister within the transfer cask is left to reach equilibrium conditions. A 600 hour (25 day) limit is, nevertheless, imposed in order to preclude the inappropriate use of the transfer cask as a storage component.

The applicant proposed the option of purging the canister with heated nitrogen (# 300EF) at low flow rates. This would not have any adverse effect on the vacuum drying times or maximum component temperatures. Backfilling the canister during the vacuum drying phase would increase the heat flow due to increased conductivity. The flow of relatively cool gas through the canister would keep the fuel and basket component temperatures lower than the vacuum condition. The original thermal transient analyses for the vacuum conditions bound the condition with nitrogen in the canister, and therefore, this option was not considered when establishing the time limits proposed in the application.

The applicant also proposed that supplemental heat may be applied to the canister during the vacuum stage by delivering hot air (170EF) at a flow of 200 CFM to the cask/canister annulus. The original transient calculations only considered conduction and radiation as means of heat transfer in the annulus region and the resulting canister temperatures were in the range of 200EF. By adding forced convection to the annulus region, not only is heat being delivered to the lower portion of the canister, but heat removal is improved in the upper portion of the canister, where maximum component temperatures are observed. The original thermal transient analyses for the vacuum conditions bound the forced hot air scenario, and therefore, this option was not considered when establishing the time limits proposed in the application.

Based on a review of the statements and representations in the application, the staff agrees that the proposed changes do not adversely affect the ability of the system to meet the thermal performance requirements of 10 CFR Part 72.

**SHIELDING EVALUATION**

The applicant did not submit a revised shielding analysis for the requested changes in this amendment request. The only addition to the contents of the cask system are unirradiated stainless steel rods in the RCCA guide tubes, which would provide some additional shielding in the lower regions of the cask.

The staff agrees that the proposed changes do not affect the ability of the system to meet the radiation protection requirements of 10 CFR Part 72.

**CRITICALITY EVALUATION**

The applicant did not submit a revised criticality analysis for the requested changes in this amendment request. The only change that would affect the reactivity of the system would be the addition of stainless steel rods in RCCA guide tubes. A revised criticality analysis is unnecessary because the effect of this change would be to reduce $k_{eff}$ due to water displacement and neutron absorption in stainless steel,

The staff agrees that the proposed changes do not affect the ability of the system to meet the criticality safety requirements of 10 CFR Part 72.

**OPERATING PROCEDURES**

The staff has reviewed the proposed changes to the operating procedures for consistency with the amendment request. The staff finds the proposed changes acceptable.

**OPERATING CONTROLS and LIMITS**

The staff has reviewed the proposed changes to the operating controls and limits for consistency with the amendment request. The staff finds the proposed changes acceptable.

**OVERALL CONCLUSION**

The NRC staff has reviewed the amendment to the SAR for the NAC-MPC system. The Certificate of Compliance has been revised to include the NAC requested changes. Those changes include (1) increasing vacuum drying time limits; (2) increasing canister in transfer cask time limits, (3) revising fuel cooldown requirements; (4) deleting canister removal from concrete cask requirements; (5) revising surface contamination removal time limits; and (6) revising allowable contents fuel assembly limits. Based on the statements and representations contained in the application, as supplemented, the staff concludes that these changes do not adversely affect the ability of the NAC-MPC storage system to meet the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1025, Amendment No. 4 on October 27, 2004.