SAFETY EVALUATION REPORT

Docket No. 72-1015
NAC-UMS® STORAGE SYSTEM
Certificate of Compliance No. 1015
Amendment No. 4

SUMMARY

By application dated August 10, 2004, as supplemented on December 23, 2004, and February 17, 2005, NAC International, Inc. (NAC) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subpart K and L, to Certificate of Compliance (CoC) No. 1015 for the NAC-UMS® Universal Storage System.

NAC requested changes to the CoC, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The amendment changes were: (1) to replace the specific term "zircaloy" with the more generic term "zirconium alloy;" (2) to revise the definitions of OPERABLE and SITE SPECIFIC FUEL; (3) to revise vacuum drying pressure and time limits; (4) to revise the short-term temperature limits and completion times for the concrete cask heat removal system; (5) to clarify the surface dose rate surveillance frequency; (6) to add an option for restoring the dissolved boron concentration; (7) to delete the redundant administrative control for boron concentration; (8) to add an alternate site-specific design basis earthquake (DBE) analysis for unbounded site conditions; and (9) to incorporate editorial and administrative changes.

The Nuclear Regulatory Commission (NRC) staff has reviewed the Safety Analysis Report (SAR) amendment application using the guidance provided in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," (SRP) January 1997. The staff performed a detailed evaluation of the proposed changes, which is documented in this safety evaluation report (SER). Only those SRP chapters with a corresponding applicant request for revision or changes are addressed in the staff's SER.

Based on the statements and representations in the application, as supplemented, the staff concludes that the NAC-UMS® Universal Storage System, as amended, meets the requirements of 10 CFR Part 72. The changes to the CoC are indicated by change bars in the margins.

STRUCTURAL EVALUATION

The major structural design change requested by the applicant was to add an alternate criterion to the Technical Specification (TS) for evaluating the cask with respect to the structural consequence of the earthquake event.

Amendment No. 3 to CoC, Appendix B, TS B 3.4.1.3, approved the site parameters of the DBE levels evaluated at the top surface of the concrete Independent Spent Fuel Storage Installation (ISFSI) pad: the minimum coefficient of friction (COF) values and two corresponding

combinations of horizontal and vertical acceleration components. The earthquake levels and COF values were established so that no vertical concrete cask (VCC) sliding or tip-over will result, in accordance with the ANSI/ANS-57.9, Section 6.17.4.1 provisions for the structural foundations stability. The applicant revised TSB 3.4.1.3 to note that, as an alternative, site-specific analysis may be performed for site conditions that are not bounded. Specifically, site-specific DBE evaluation parameters are limited so that (1) the deceleration g-load resulting from the collision of two sliding VCCs remains bounded by the accident analyses of the FSAR and (2) the cask does not slide off the ISFSI pad.

FSAR Section 11.2.8.2.2 presents the earthquake stability analysis approved for the VCC restrained from sliding and tipover on an ISFSI pad. For sites permitting VCC sliding, proposed SAR Section 11.2.8.2.4, provided an evaluation of the collision of two individual free standing VCCs moving toward each other. Using an energy balance method, which equates the initial kinetic energy of the colliding VCCs to the total energy dissipated by the crushed concrete shells, the applicant integrated the incremental dissipated energy to determine the final concrete crush depth and contact area. The collision g-load was then estimated as the product of the compressive concrete strength and the final contact area, normalized by the mass of the loaded VCC. To establish bounding earthquake performance of the VCC permitted to slide and collide, the applicant noted the approved design basis tipover decelerations of 40 g and 30 g for the three classes of pressurized water reactor (PWR) and two classes of boiling water reactor (BWR) casks, respectively. Considering VCC geometry, weight, and relevant attributes, such as dynamic load factors for cask internals evaluation, the applicant calculated the limiting cask colliding velocities of 68 in/sec and 50 in/sec for the PWR and BWR cask classes, respectively, for which the collision g-loads are bounded by those associated with the tipover accident. This demonstrates that, for the VCCs allowed to slide and collide with limited velocities, the resulting stresses and deformations of the basket and canister also remain bounded by those evaluated previously for the tipover accidents.

The staff reviewed the requested TS changes to allow the VCC to slide on the ISFSI pad during the DBE. The staff agrees that, for site conditions not bounded by those of TS B 3.4.1.3(a), the cask user may consider the earthquake motion of the ISFSI pad such that the impact g-load resulting from the collision of two sliding VCCs remains bounded by the accident condition analyses provided in the FSAR. A supplemental statement was also added to the TS to require an evaluation of VCC movement to demonstrate that the VCC does not slide off the ISFSI pad, thereby averting the VCC tipover accident. The TS changes address the need for evaluating cask earthquake performance in accordance with the standard review plan, NUREG-1536, provision, which states, “The applicant should demonstrate that no tipover or drop will result from an earthquake. In addition, impacts between casks should either be precluded, or should be considered an accident event for which the cask must be shown to be structurally adequate.” On this basis, the staff concludes that the requested TS changes will not adversely affect the ability of the NAC-UMS® system to meet the regulatory requirements of 10 CFR Part 72.

THERMAL EVALUATION

The thermal review confirmed that the cask and fuel material temperatures of the NAC-UMS® system will remain within the allowable values or criteria for normal, off-normal, and accident conditions. This included confirmation that the temperatures of the fuel cladding (fission

product barrier) will be maintained throughout the storage period to protect the cladding against degradation, which could lead to gross rupture. The thermal review also confirms that the design of the cask has been evaluated using acceptable analytical and/or testing methods.

The staff reviewed the applicant's request to change the term "Zircaloy" to a more generic term, "Zirconium alloy" with respect to the following regulatory requirements:

- 10 CFR 72.122h(l), the spent fuel cladding must be protected during storage against degradation that leads to gross rupture in the fuel or the fuel must otherwise be confined such that the degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage.

- 10 CFR 72.236(m) states in part "… to the extent practicable, consideration should be given to compatibility with removal of the stored spent nuclear fuel to transportation and ultimate disposal by the DOE."

The staff has evaluated the expected behavior of zirconium alloy claddings (also known as advanced claddings) for storage in the NAC-UMS® system at a maximum burnup of 50 GWd/MTU and concludes that zirconium alloy claddings are acceptable for storage in the NAC-UMS® system.

The proposed NAC-UMS amendment changes affecting thermal performance were:

(1) the TS definition of OPERABLE, to eliminate the need for continuous monitoring of the VCC temperature difference, as well as, changes to the applicable portions of Limiting Condition for Operation (LCO) 3.1.6 "Concrete Cask Heat Removal System"

(2) LCO 3.1.2, "Canister Vacuum Drying Pressure" to reduce the vacuum holding time from 30 minutes to 10 minutes and increase the vacuum drying pressure to #10 mm Hg from 3 mm Hg, and

(3) Operating Procedure 8.1.1, "Loading and Closing the Transportable Storage Canister" resulting from changes by NAC, as authorized under the provisions of 10 CFR 72.48.

With regard to changing the definition for operability and LCO 3.1.6, the staff did not object to adding the option of performing a visual inspection of the inlet and outlet screens. Acceptance of the visual surveillance was predicated upon initially performing, on a one time basis, a verification of the temperature difference between the ambient and the cask outlets. The staff position is that this initial verification ensures that the cask is loaded within its thermal design basis and has not been inadvertently thermally overloaded. The justification for the staff's position is that once the cask is properly loaded, its temperatures should continue to decrease proportional to the decay heat curve and any minor temperature fluctuations are only a result of environmental conditions. Additionally, the staff noted that LCO 3.1.6 did not specify any other action for an inoperable cask other than placing the canister into the transfer cask. The staff did not consider this action sufficient to prevent a thermally overloaded cask from sitting too long within the transfer cask. The staff concerns were addressed by revising LCO 3.1.6(B) to require an engineering evaluation if LCO 3.1.6(A) is not met.
With regard to increasing the vacuum drying pressure to #10 mmHg and shortening the drying

time to 10 minutes, the staff believes that significant water will remain in the cask (post vacuum drying) considering all the possible, but undefined loading conditions associated with the NAC-UMS. Specifically, the staff was concerned that without a certain amount of heat input from the canister and its internals, significant water could remain within the canister as would be the case during vacuum drying assuming a constant enthalpy process as pressure decreases. The applicant demonstrated that, if the spent fuel pool and loading area environmental temperature was $65EF, then ample heat would be available to evaporate the residual water to an acceptable level. As a result, a precaution was added to the operating procedures alerting personnel as to the temperature sensitivity of the vacuum drying process. Additional assurance that the water will be removed from the canister is provided by the helium filling process, which entails drawing two successive vacuum pressures to #3mmHg. The staff concluded that these methods will reduce the water in the canister to acceptable levels consistent with the guidance provided in PNL-6365, "Evaluation of Cover Gas Impurities and Their Effects on the Dry Storage of LWR Spent Fuel."

The staff was also concerned with the proposed changes to LCO 3.1.2 and the Operating Procedure 8.1.1 Step 30, which stated that the vacuum pump would be "isolated" rather than shut down once the vacuum pressure was reached and the time duration for holding the vacuum began. Because leakage past the vacuum pump system would cause the canister pressure to rise and the system would fail safe, the staff suggested shutting off the vacuum pump. The applicant's initial response was to add "isolation of the vacuum pump" to both the technical specification and the operating procedure. Although this option presumes no leakage past the isolation valve under vacuum conditions, the staff noted that possible leakage past the isolation valve would invalidate the results. The vacuum pump could remove water vapor that would cause the canister pressure to rise above the 10 mm Hg limit. Because this valve is part of the vacuum drying equipment, which is non-safety related and not regularly tested, the staff could not accept the lone closure of this isolation valve as the isolation boundary. The applicant then chose to isolate the vacuum pump and let it continue running to reduce cycling on the pump and to save time during the vacuum drying operation. The staff viewed this as a non-failsafe configuration unless some means of removing vacuum pressure from the pump side of the isolation valve was provided. The applicant agreed to shut off the vacuum pump when performing vacuum pressure rise test.

The applicant made various changes to Operating Procedure 8.1.1, as a result of staff requested clarifications including but not limited to the following:

- adding a precautionary note to Step 28 requiring a partially drained canister to be refilled with water prior to the start of cooling operations (i.e., either forced air or in-pool) identified in Step 12.

- adding a note to Step 28 stating, that the time from completion of draining to the filling the canister with helium is a part of the vacuum drying operation (i.e., LCO 3.1.1), thereby clarifying that the blowdown of the canister with nitrogen is a part of the draining operation.

The staff reviewed the information provided by the applicant and agrees that blowdown can be defined as part of the draining operation and these arguments are now included in the thermal chapter, SAR Section 4.4.1.3. The technical justification includes, in part, that the design basis analysis takes no credit for the heat rejection from the latent heat of evaporation, nor for

discharging heated water from the canister.

Based on the information presented in the SAR, the applicant's analysis, and the staff's independent calculations, the staff finds that this amendment provides reasonable assurance that the storage cask's material temperatures will be maintained below their limits, that the applicant has used acceptable analytical and test methods, and therefore, that the NAC-UMS® system meets regulatory requirements of 10 CFR Part 72.

CRITICALITY

The applicant revised the SAR for the NAC-UMS® system to change the allowable cladding types for all fuel assemblies from Zircalloy to the more generic "Zirconium Alloy." This change has no effect on the criticality safety of the NAC-UMS® system.

The applicant also revised the SAR to allow the storage of solid stainless steel rods in the guide tubes of PWR assemblies. Solid stainless steel rods are only allowed for storage in PWR assemblies, which do not require credit to be taken for soluble boron in the moderator in order to meet the assembly enrichment limit. Because the displacement of unborated moderator provided by the addition of stainless steel rods would lead to a decrease in reactivity, the applicant conservatively neglects the presence of these rods in the criticality analysis.

The applicant has shown and the staff agrees that the proposed changes to the NAC-UMS® system do not affect the previously approved criticality analysis for the system.

ADMINISTRATIVE CHANGES

The applicant proposed changing the wording for the Surveillance Requirement (SR) 3.2.2.1 frequency from "once prior to transport operations" to "prior to storage operations." The surveillance verifies that the concrete cask average surface dose rate is within limits. The wording change is consistent with the LCO applicability designation of storage. The limits of the surveillance are bounded by the shielding safety analysis. This change does not affect the shielding analysis.

The applicant proposed an addition to LCO 3.3.1 that provides an option for restoring dissolved boron concentration within 24 hours during loading and unloading operations. This provision clarifies continued operations if the boron concentration is restored to LCO limits. This change is bounded by the criticality analysis and has not affect on criticality safety.

The applicant requested removal of TS A5.7, which is an administrative control to assure proper boron concentration for the spent fuel pool and water in the canister. TS A5.7 refers to the requirements of LCO 3.3.1 for measuring and maintaining boron concentration. The staff agrees that the administrative control is redundant to the TS limiting condition for operation and does not affect the safe operation of the NAC-UMS® system.

CONCLUSION

The NRC staff has reviewed the amendment application for the NAC-UMS® system. The staff considered the regulation, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices in reaching its conclusion. Only the affected SRP sections were included in the SER. The remaining sections were not addressed in the amendment application and were not affected. The Certificate of Compliance has been revised to include the changes requested by NAC. Those changes include: (1) replacing the "zircaloy" with "zirconium alloy"; (2) revising the definitions of OPERABLE and SITE SPECIFIC FUEL; (3) revising vacuum drying pressure and time limits; (4) revising short-term temperature limits and completion times for the heat removal system; (5) clarifying the surface dose rate surveillance; (6) adding a dissolved boron concentration option; (7) deleting a redundant boron concentration administrative control; (8) adding an alternate site-specific DBE analysis; and (9) incorporating editorial changes.

Based on the statements and representations contained in the application, as supplemented, the staff concludes that these changes do not affect ability of the NAC-UMS® Universal Storage System to meet the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1015, Amendment No. 4 on October 11, 2005.