PRELIMINARY SAFETY EVALUATION REPORT

Docket No. 72-1015
NAC-UMS CASK SYSTEM
Certificate of Compliance No. 1015
Amendment No. 2

SUMMARY

By application dated October 17, 2000, as supplemented December 7, 2000, and April 27, July 5, July 18, July 19, July 26, and August 1, 2001, NAC International, Inc. (NAC) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subpart K, to the Certificate of Compliance for the UMS Universal Storage System.

The NAC-UMS system (the cask) 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. The cask stores up to 24 pressurized water reactor (PWR) fuel assemblies or 56 boiling water reactor (BWR) fuel assemblies.

For this amendment to the Certificate of Compliance, NAC requested (1) changes to authorized contents to allow Maine Yankee to store various components associated with the spent fuel assemblies; (2) a Technical Specification change to delete the requirement to place a TSC in the transfer cask if the associated VCC's vents cannot be unblocked; and (3) editorial clarifications, administrative changes and correction of discrepancies in the Technical Specifications (TS).

NRC staff reviewed the application using the guidance in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems." Based on the statements and representations in the application, as supplemented, and the conditions discussed in this Safety Evaluation Report (SER), the staff concluded that the NAC-UMS cask meets the requirements of 10 CFR Part 72. The changes to the Certificate of Compliance are indicated by change bars in the margin. Changed pages in Appendices A and B of the Certificate of Compliance are indicated by "Amendment 2" in the lower right corner of each changed page, and by change bars in the margin.

1.0 GENERAL DESCRIPTION

1.1 System Description

The NAC-UMS system is a transport-compatible dry storage system that uses a stainless steel TSC stored within the central cavity of a VCC. The TSC is designed to be compatible with the NAC-UMS transport cask to allow future shipment. The VCC provides radiation shielding and contains internal air flow paths that allow decay heat from the TSC spent fuel contents to be removed by natural air circulation around the canister wall.

The principal components of the NAC-UMS system are the TSC, the VCC, and the transfer cask. The transfer cask is used to move the loaded TSC to and from the VCC and provides radiation shielding while the TSC is being closed and sealed. The TSC is placed in the VCC by positioning the transfer cask on top of the VCC and subsequently lowering the TSC.

1.2 Contents

The applicant requested changes to the authorized contents for Maine Yankee to include components associated with the spent fuel assemblies, as follows:

A. Allowable Contents

1. A segment of an ICI string approximately 24 inches long, loaded in the corner guide tube position of an intact fuel assembly
2. Three Pu-Be startup sources, loaded in the center guide tubes of fuel assemblies that are loaded in a corner position of the basket. One of the three sources is unirradiated.
3. Two Sb-Be sources, loaded in the center guide tubes of fuel assemblies that are loaded in a corner position of the basket.
4. Control Element Assembly (CEA) Finger Tip, inserted into the guide tubes of a fuel assembly, loaded in a corner position of the basket.

Detailed loading requirements for the above contents may be found in Appendix B to the Certificate of Compliance. The staff reviewed the applicant's request to authorize the components associated with the Maine Yankee spent fuel as contents and concludes that they will not affect the ability of the cask to meet the requirements of 10 CFR Part 72.

1.3 Technical Specification Changes

The applicant also requested several changes to the Technical Specifications. These changes are discussed i detail in Section **12**, below. The staff concludes that the applicant's requested Technical Specifications changes will not affect the ability of the cask to meet the requirements of 10 CFR Part 72.

2.0 PRINCIPLE DESIGN CRITERIA

The applicant revised this section to include the various components to be stored that are associated with fuel assemblies. This change is technically evaluated in the sections that follow. Based on those reviews, the staff concludes that the revisions to Safety Analysis Report (SAR) Section 2 are acceptable, and continue to meet the requirements of 10 CFR Part 72.

3.0 STRUCTURAL

3.1 General Structural

The additional components associated with fuel assemblies, which are inserted into guide tubes and added as allowable contents, include startup sources, Control Element Assembly (CEA) fingertips, and a 24-inch segment of an in-core instrumentation (ICI) string. These components are preferentially loaded at the canister corner positions. Since weights of these components

are minimal, they impose no additional structural constraints on the NAC-UMS system as previously approved. Based on the applicant's structural evaluation for this amendment, the staff has reasonable assurance that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

3.2 Materials

In Section 3.4.1.1 of the SAR, the applicant evaluated whether chemical, galvanic, or other reactions among the additional fuel-related items and the existing internal fuel components would occur when exposed to the various environments of the DCSS. The staff reviewed the design drawings, applicable sections of the SAR, and Request for Additional Information (RAI) response to evaluate the effects, if any, of intimate contact between fuel-related items and the existing internal fuel components. In particular, the staff reviewed whether the additional components would degrade the zircaloy fuel cladding during all phases of operation of the DCSS. Likewise, the staff evaluated whether these contacts could initiate a significant chemical or galvanic reaction that could result in component corrosion or combustible gas generation. Pursuant to NRC Bulletin 96-04, staff concluded that the additional items associated with fuel assemblies within the NAC-UMS system will produce no adverse chemical or galvanic reactions with the zircaloy cladding during operation (e.g., short-term loading/unloading or long-term storage). Furthermore, the staff concluded that since most of these elements are fabricated from stainless steel (no carbon steel, coated, or aluminum fabricated elements), no possible generation of hydrogen or other flammable gases should occur during storage.

The applicant has met the requirements of 10 CFR 72.236(h) and 236(m). The material properties of SSCs important to safety will be maintained during normal, off-normal, and accident conditions of operation so the spent fuel can be readily retrieved without posing operational safety problems.

4.0 THERMAL

The thermal review ensures that the cask and fuel material temperatures of the NAC-UMS system for Maine Yankee will remain within the allowable values or criteria for normal, off-normal, and accident conditions. This objective includes 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. This review also confirms that the thermal design of the cask has been evaluated using acceptable analytical and/or testing methods.

This amendment requests that the NAC-UMS for Maine Yankee approved contents include addiitonal components associated with fuel assemblies (i.e. control element assembly fingertips, start-up sources, and a few feet of length of an in-core instrumentation string). The additional components have a small amount of decay heat associated with them, ranging from 0.4 watts for the CEA fingertips to 9.6 watts for an irradiated Pu-Be source, which equates to approximately 1% of an assembly's maximum design basis heat load. Also requested was a change to the Technical Specification LCO 3.1.6 to delete putting the canister in the transfer cask when the concrete cask can't perform its heat removal function.

In reviewing this amendment, the staff noted that the additional components can only be located in the corner positions of the basket. These corner locations, in combination with the small amount of heat generated from the additional components, would have a negligible effect on the maximum cladding temperatures which would be in the center of the basket. Also, the Technical Specifications maintain the assembly loads to less than certain design basis values (i.e. 0.958 kW for standard & preferential loadings, and 1.05 kW for high burn-up fuel), and the canister heat loads to less than the values shown on SAR Tables 4.4.7-8 “Maximum Allowable Decay Heat for UMS PWR” & 4.5.1.2-3 “Maximum Allowable Canister Heat Loads for 50,000 MWD/MTU Burn-up Fuel”. Therefore, the additional components have no significant effect on previously analyzed material temperatures and are bounded by the previously licensed design basis.

Also, the applicant requested that the Required Action B.2.2 of LCO 3.1.6 be deleted since the likelihood of having to place the canister in the transfer cask (as a result of the concrete cask not being able to perform its heat transfer function) is very small. The staff concurs with this request since the risk of a cask not performing its thermal function is less than the risk of a fuel assembly misloading event. Misloading events have occurred at facilities storing spent fuel under 10 CFR Part 72. However, the NRC has previously decided that the overall risk associated with a misloading event does not warrant special consideration within the thermal analysis arena because there is no adverse safety impact. Below is a discussion of the risk of a misloading event, and following it a comparison with the risk of the cask failing to perform its thermal function.

A misloading, in a worst case scenario, would cause some rods to overheat and possibly result in fuel cladding rupture. However, the fuel would remain in its analyzed configuration since the rupture openings would be small for ductile cladding. Also, the containment boundary of the storage canister would remain intact since it is designed for pressure increases resulting from a postulated failure of all fuel rods. Since risk is defined as frequency times consequence, the overall risk associated with a misloading event would be acceptable because there are no adverse consequences as long as the containment boundary remains intact, even though some misloading events have occurred and could possibly occur again.

In comparison, the overall risk of a concrete cask not performing its thermal function is smaller than that of a misloading since, (1) surveillances are used to assure operational functionality, (2) redundancy is provided in the cask’s heat removal pathways, (3) no such event has occurred to date (whereas misloading events have), and (4) the heat load in the case of the cask not performing its thermal function would be below its design basis, whereas for a misloading it could be above its design basis. Therefore, the staff believes that the risk for this request is reasonably low enough to grant this request because there is no adverse safety impact. Furthermore, LCO 3.1.7 maintains the option of placing a canister in a transfer cask, and ensuring the proper cooling, although this action would not be a requirement during storage, as LCO 3.1.7 only applies during TRANSFER OPERATIONS.

Based on the information presented in the SAR and NRC judgements on misloading risk, as described above, the staff finds that this amendment presents reasonable assurance that the storage cask’s material temperatures will be maintained below their limits, and that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

5.0 SHIELDING

The additional components to be stored with the MY fuel in the UMS consist of: three plutonium-beryllium (Pu-Be) neutron sources; two antimony-beryllium (Sb-Be) neutron sources; control element assembly (CEA) fingertips; and an ICI string segment. Two of the Pu-Be sources have been irradiated and one is unirradiated. The two Sb-Be sources have been irradiated.

The curie content for the additional MY hardware and neutron sources was characterized. Based upon the information from the characterization, and using ORIGEN-S, the source term for the additional hardware and neutron sources was determined. The spectra for both the gamma and the neutron contributions for the source term was a small fraction of the total for the design basis fuel.

The neutron sources will be inserted into the center guide tubes of five different assemblies and loaded into Class 1 canisters. Each of the assemblies will be loaded into a different canister. The CEA fingertips and ICI string segment may be inserted into one or more assemblies and a CEA flow plug will be installed to close the guide tubes with the added hardware. The assemblies with the extra hardware will be loaded into a longer Class 2 canister to accommodate the CEA flow plug. Assemblies loaded with either the neutron sources or hardware will be loaded into a corner position in the fuel basket.

Due to the manner in which the additional hardware and neutron sources will be loaded into assemblies and canisters, any increase in dose rate on the surface of the concrete cask will be negligible.

Staff reviewed the information provided in the SAR regarding the source term information for the additional hardware and neutron sources and determined that the source term and dose rates from this material are bounded by the design basis PWR fuel. Therefore, staff has reasonable assurance that the requirements of 10 CFR Part 20, 10 CFR 72.104 and 10 CFR 72.106 will be met.

6.0 CRITICALITY

The staff reviewed the criticality analysis to ensure that all credible normal, off-normal, and accident conditions have been identified and their potential consequences on criticality considered such that the NAC UMS system, as revised, meets the following regulatory requirements: 10 CFR 72.24(c)(3), 72.24(d), 72.124, 72.236(c), and 72.236(g). The following proposed changes were considered for their impact on the criticality safety evaluation;

a. Revision of the Maine Yankee fuel contents only to allow up to 4 start-up sources per cask.
b. Revision of the Maine Yankee fuel contents only to allow control element assembly (CEA) fingertips or ICI string segments.

The start-up sources, CEA fingertips, and ICI string segments are to be placed in a center or corner guide tube of an INTACT fuel assembly, as limited in the Technical Specifications. These assemblies are limited to storage in the corner positions of the canister.

The staff's conclusions, summarized below, are based on information provided in the revised NAC UMS SAR submitted October 17, 2000, as supplemented.

6.1 Start-up Sources in Maine Yankee Fuel Assemblies

The applicant requested the addition of Maine Yankee fuel assemblies containing start-up sources to the NAC UMS approved contents. The Maine Yankee fuel assembly was previously approved for storage in the NAC UMS system.

These are either Pu-Be or Sb-Be sources and are located in the center guide tube. Since beryllium is a very effective neutron moderator/reflector, and since some of the sources contain plutonium, the applicant performed calculations to determine their effect on the system reactivity. The analysis assumes that assemblies with start sources are located only in the four basket corner fuel positions. The applicant's calculations show that the NAC UMS, loaded with Maine Yankee fuel, will meet the design criterion of keff $\leq$ 0.95.

Using the previously reviewed analysis for the NAC UMS design basis contents (Westinghouse 17x17 OFA), the staff adjusted the applicant's calculated keff for the site-specific contents to account for the effects of worst-case dimensional tolerances and shifting within the canister basket. The staff multiplied the worst-case design-basis fuel keff (including bias and uncertainty) by the ratio of the computed keff for the site-specific fuel containing the sources to the computed keff for the reference design-basis fuel model. The staff agrees that storage of Maine Yankee fuel assemblies, with four assemblies containing a start-up source, is bounded by the current criticality safety analysis for the design basis fuel.

6.2 CEA Fingertips and ICI String Segments in Maine Yankee Fuel Assemblies

The applicant also requested revision of the approved contents to allow storage of Maine Yankee fuel assemblies with CEA fingertips or ICI string segments in the NAC UMS system. These components, which are inserted in one of the four corner guide tubes, are approximately 24 inches long and do not contain any fissile or moderating material. The NAC UMS uses fresh water during loading/unloading operations. Since these components are replacing water in an undermoderated system and the amount of fissile material remains the same, there will not be an increase in reactivity. Therefore, further evaluation is not necessary.

6.3 Summary

The staff did not review the methods used by the applicant since this was an amendment to a previously approved storage cask system. The staff notes that the methods were consistent with the previous application. The applicant explicitly modeled the assemblies using the same computer code and cross section set used in the original application. The applicant used three-dimensional calculational models in its criticality analyses.

Based on the applicant's criticality evaluation for this amendment, the staff has reasonable assurance that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

7.0 CONFINEMENT

The pressure evaluation of the standard NAC-UMS storage canister was determined to be bounding since the assumptions of the original confinement evaluation are not impacted by the inclusion of the fuel-related components. The confinement evaluation therefore remains bounding for the changes in this amendment.

8.0 OPERATING PROCEDURES

The applicant requested no changes to the operating procedures due to this amendment. The staff concludes that the operating procedures continue to provide reasonable assurance that the requirements of 10 CFR Part 72 will be met, as the changes in this amendment do not impact the procedures as described in SAR Chapter 8.0 for TSC loading, closure, removal and unloading, or VCC loading, transport and placement.

9.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The applicant revised this section to reflect that daily air inlet and outlet temperature monitoring may be done remotely, and a visual inspection need not be performed unless a decline in thermal performance is noted. Additionally, this section requires thermal testing be performed for the first NAC-UMS system placed in service with a heat load equal to or greater than 10 kW. The results of this testing, and the associated analyses and calculations are to be reported in accordance with 10 CFR 72.4. The revised requirement would delete the requirement for subsequent reports to be prepared for each subsequent cask loaded with a higher heat load. In the revised requirement, if the first report demonstrates the performance of the system, then no subsequent reports would be required. The staff reviewed the revisions to SAR Section 9 and concludes that it continues to provide reasonable assurance that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

10.0 RADIATION PROTECTION

The applicant revised this section to correspond to the changes to Section 9 for remote temperature monitoring, as discussed above. The staff reviewed the revisions to SAR Section 10 and concludes that it continues to provide reasonable assurance that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

11.0 ACCIDENT ANALYSES

The applicant evaluated the Maine Yankee Site Specific Fuels (MYSSF) for off-normal and accident events. Following the same methodology used previously for the high burnup fuel with a cladding oxide layer of 80 microns thick, the applicant added to SAR Section 11.2.15.1.5 a buckling evaluation for fuel rods with an oxide layer of 120 microns. This was done by considering a 60 g design basis axial impact load as impulsive and short duration in nature to arrive at an equivalent static load of 14.3 g. This load is below the ANSYS computed fuel rod buckling capability of 37.3 g, and is acceptable. Based on the applicant's accident analyses for this amendment, the staff has reasonable assurance that the proposed changes will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.

12.0 CONDITIONS FOR CASK USE - TECHNICAL SPECIFICATIONS

Revised TS have been incorporated in support of the application. The revisions include:

- SR 3.1.2.1, “CANISTER Vacuum Drying Pressure” and SR 3.1.3.1, “CANISTER Helium Backfill Pressure” was modified to change the frequency requirement from once within 10 hours after completion of CANISTER draining to “Prior to TRANSPORT OPERATIONS”. This change was made to correct a discrepancy in the Technical Specifications to be consistent with the longer vacuum drying times for low heat load canisters currently allowed by TS 3.1.1, and previously reviewed and approved as part of Amendment 1. TS 3.1.1 continues to require that the surveillances be performed within the required time periods for vacuum drying and testing. SR 3.1.2.1 and SR 3.1.3.1 also continue to ensure that the proper LCO actions would be followed if completion of a surveillance following vacuum drying and helium backfill yields unsatisfactory results. Therefore, based on the applicant’s justification for this TS change, the staff has reasonable assurance that the proposed change will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.
- LCO 3.1.6, “CONCRETE CASK Heat Removal System” was modified to delete the requirement to place the canister in the transfer cask if the VCC’s vents cannot be unblocked within the required completion time. This change is consistent with the requirements of 10 CFR Part 72, as discussed in section 4.0 of this SER.
- Surveillance Requirement 3.2.1.1, related to the surveillance to check the removable surface contamination on the canister was changed to delete the reference to the canister containing fuel, as this amendment allows certain fuel-related components to also be stored. This change is consistent with the requirements of 10 CFR Part 72, as discussed in the previous sections of this SER.
- Section A 5.3, “Special Requirements for the First System Placed in Service” was modified. This section requires thermal testing be performed for the first NAC-UMS system placed in service with a heat load equal to or greater than 10 kW. The results of this testing, and the associated analyses and calculations are to be reported in accordance with 10 CFR 72.4. The revised requirement would delete the requirement for subsequent reports to be prepared for each subsequent cask loaded with a higher heat load. In the revised requirement, if the first report demonstrates the performance of the system, then no subsequent reports would be required. Based on the applicant’s justification for this TS change, the staff has reasonable assurance that the proposed change will not affect the ability of the package to meet the requlatory requirements of 10 CFR Part 72.
- Section A 5.7, “Verification of Oxide Layer Thickness on High Burnup Fuel” was revised to state that high burnup fuel is classified as damaged fuel, instead of stating that it is stored as damaged fuel. The requirements for storage of damaged fuel continue to be contained in Table B2-7, therefore this change is consistent with the requirements of 10 CFR Part 72.
- Section B 2.1, “Fuel Specifications and Loading Conditions” was revised to delete reference to the old Revision 0 of the Certificate of Compliance. This change ensures Revision 0 is not considered part of the design or licensing basis, as the current revision only should be utilized. This change is consistent with the requirements of 10 CFR Part 72.

- Section B 2.1.3, “Maine Yankee SITE SPECIFIC FUEL Preferential Loading” was revised to include specifications for loading of the fuel-related components, as discussed in the previous sections of this SER. This change is consistent with the requirements of 10 CFR Part 72.
- Table B2-2, “PWR Fuel Assembly Characteristics” was changed for Fuel Class 3 to correct typographical errors in some of the fuel assembly parameters for the CE 16x16 fuel. This change is consistent with the requirements of 10 CFR Part 72.
- Table B2-6, “Maine Yankee Site Specific Fuel Canister Loading Position Summary” was revised to remove annotations and requirements that are redundant to those listed in Table B2-7, and to re-format certain aspects of the table. It was also revised to include the various components associated with fuel assemblies, and their canister loading position requirements. This change is consistent with the requirements of 10 CFR Part 72, as discussed in the previous sections of this SER.
- Table B2-7, “Maine Yankee Site Specific Fuel Limits” was revised to include provisions for the various components associated with fuel assemblies. It was also revised to move certain requirements from Table B2-6, as discussed above, to this table. This change is consistent with the requirements of 10 CFR Part 72, as discussed in the previous sections of this SER.
- Various pages are also changed and noted “Amendment 2" due solely to page numbering changes or small editorial and grammatical changes.
- Various pages have been changed from being noted “Amendment 0" to being noted “Amendment 1", as the applicant discovered that Amendment 1 had been previously issued with some changed pages not properly annotated. These changes are editorial, and are to ensure proper documentation of historic changes.

As stated above, the staff concludes that the amended conditions for use of the NAC-UMS system identify necessary specifications to satisfy 10 CFR Part 72 and that the applicable acceptance criteria have been satisfied. The Certificate of Compliance and attached appendices provide reasonable assurance that the cask will allow safe storage of spent fuel.

CONDITIONS

Conditions 1.b and 6 of the Certificate of Compliance have been modified to reflect the addition of components associated with spent fuel assemblies as contents.

CONCLUSION

The staff reviewed the revised Safety Analysis Report for the NAC-UMS storage cask system. Based on the statements and representations contained in the SAR and the conditions in the Certificate of Compliance, the staff concludes that the NAC-UMS storage cask system meets the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1015, Amendment No. 2,
on _____, 2001.