PRELIMINARY SAFETY EVALUATION REPORT
NAC INTERNATIONAL, INC.
MAGNASTOR® STORAGE SYSTEM
DOCKET NO. 72-1031
AMENDMENT NO. 14 AND REVISION TO AMENDMENT NOS. 0–13

Summary

On March 10, 2023 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML23069A215), NAC International, Inc. (NAC), reported to the U.S. Nuclear Regulatory Commission (NRC) a self-identified licensing basis deficiency for the NAC-UMS and MAGNASTOR® dry cask storage systems in accordance with requirements set forth in Title 10 of the *Code of Federal Regulations* (10 CFR) 72.242, “Recordkeeping and reports.” In its report, NAC stated that a parameter used in its non-mechanistic tipover calculation was incorrectly specified for both the NAC-UMS and MAGNASTOR® storage systems.

By letters dated July 24, 2023 (ML23205A238 and ML23208A062), as supplemented on June 26, 2024 (ML24179A071), October 18, 2023 (ML23291A167) and August 6, 2024 (ML24219A227), NAC submitted an application for Amendment No. 14 and revisions to Amendment Nos. 0 through 13 for Certificate of Compliance (CoC) No. 1031 for the MAGNASTOR® storage system. In support of these requests, NAC submitted revisions 23C and 24A of the MAGNASTOR® final safety analysis report (FSAR). Specifically, NAC requested approval of:

- a revised method of evaluation (MOE) for the non-mechanistic tipover accident correcting the parameter’s error
- revised definitions of damaged and undamaged fuel in the technical specifications to clarify that damaged or missing grid spacers only applies to PWR fuel assemblies
- revised inlet and outlet vent blockage and surveillance requirements in limiting condition for operation 3.1.2, “STORAGE CASK Heat Removal System,” in Appendix A to the CoC and associated technical specification bases and
- removal of the reference to Type II Portland cement in the description of the CoC

NAC did not request to make any changes to the storage system hardware or contents. The NRC is also correcting a typographical error in tables B2-10c and B2-10d in Revision 1 to Amendment Nos. 11 to 13.

The NRC staff reviewed the amendment request using guidance in NUREG-2215, “Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities - Final Report,” dated April 2020. For the reasons stated below and based on the statements and representations in NAC’s application, as supplemented, and the conditions specified in the certificate of compliance and the technical specifications (TS), the staff concludes that the requested changes meet the requirements of 10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.” This safety evaluation report (SER) only includes chapters from NUREG-2215 that are applicable to a dry cask storage certificate of compliance.

1.0 GENERAL INFORMATION EVALUATION

MAGNASTOR® Storage System

General Description and Operational Features

The MAGNASTOR® system used to store spent fuel consists of a transfer cask, storage overpack and a welded, stainless steel transportable storage canister (TSC) that contains the spent fuel. In the storage configuration, the TSC is placed in the central cavity of the storage overpack. The storage overpack provides structural protection, radiation shielding, and internal airflow paths that remove the decay heat from the TSC surface by natural air circulation. The storage overpack also provides protection during storage for the TSC and the spent fuel it contains against adverse environmental conditions. The MAGNASTOR® system is designed to accommodate storage of up to 37 pressurized-water reactor (PWR) fuel assemblies or 89 boiling-water reactor (BWR) fuel assemblies.

The transfer cask is used to move the TSC between the workstations during TSC loading and preparation activities, and to transfer the TSC to or from the overpack. There are three approved designs for the transfer cask, the standard MAGNASTOR® transfer cask (MTC), and the passive MAGNASTOR® transfer cask (PMTC) and the lightweight MAGNASTOR® transfer cask (LMTC). The MTC provides shielding during TSC movements between workstations, the overpack, or the transport cask. It is a multiwall (carbon steel/lead/NS-4-FR/steel) design with retractable (hydraulically operated) bottom shield doors that are used during loading and unloading operations. There is a second version of the MTC, called the MTC2. The only difference from the MTC is that the MTC2 has stainless steel walls.

Storage Overpack

The MAGNASTOR® system is a spent fuel, dry storage system consisting of a storage overpack containing a welded, stainless steel transportable storage canister (TSC) which contains the spent fuel, and a transfer cask. There are two types of storage overpacks, a concrete cask or a metal storage overpack (MSO).

The concrete overpack has varying concrete strengths and differing dimensions and to accommodate slightly different TSC designs. The concrete overpack is a right circular cylinder with a reinforced, structural concrete shield wall and a carbon steel inner liner and base. The reinforcing steel rebar is encased within the concrete. The concrete overpack contains inlet air vents at the bottom and outlet air vents at the top for convective air flow. The convective air flow removes decay heat from the TSC shell.

The metal storage overpack is a cylindrical, structural shield wall formed with carbon steel inner and outer liners that encase the NS-3 neutron shielding material. The metal storage overpack has a carbon steel inner base. The NS-3 shield wall and steel liners provide the neutron and gamma radiation shielding for the stored spent fuel. The inner and outer liners provide the structural strength to protect the TSC and its contents. The metal storage overpack provides an annular air passage to allow natural circulation of air around the TSC to remove the decay heat from the contents. The lower air inlet and upper air outlet vents are carbon steel penetrations in the bottom weldment and inner liner, respectively. Each air inlet/outlet vent is covered with a screen. The weldment baffle directs the air upward and around the pedestal that supports the TSC.

Transportable Storage Canister

The stainless steel TSC assembly holds the fuel basket structure and confines the contents. There are two TSC lengths that contain the fuel baskets to hold PWR and BWR fuel assemblies. The TSC is defined as the confinement boundary during storage.

Drawings

NAC did not submit any revised drawings for this amendment.

Proposed Changes

NAC proposed to revise the certificates of compliance and Appendix A of the TS by clarifying in the definition of damaged and undamaged fuel that damaged or missing grid spacers only applies to PWR fuel assemblies, providing a revised MOE for the non-mechanistic tipover accident; clarifying the inlet and outlet vent blockage and surveillance requirements in limiting condition for operation 3.1.2 in Appendix A to the CoC and associated technical specification bases in the SAR; revised definitions of damaged and undamaged fuel in the technical specifications to clarify that damaged or missing grid spacers only applies to PWR fuel assemblies; and removed the reference to Type II Portland cement in the CoC.

3.0 PRINCIPAL DESIGN CRITERIA EVALUATION

The change for the maximum fuel clad yield stresses associated with principal design criteria is discussed and evaluated in chapter 4 of this SER.

4.0 STRUCTURAL EVALUATION

4.1 Introduction

In their calculation 71160-2025, Rev.1, “Fuel Assembly Structural Evaluation for the MAGNASTOR and UMS Storage End Drop Condition,” NAC inadvertently used the outer radius instead of the outer diameter of the fuel rod in the ANSYS model of the fuel basket. This modeling error was introduced in Amendment No. 0 and remained unchanged through Amendment No. 13. The error is specific to the non-mechanistic tip-over analysis, as the same ANSYS model was used for computing the resulting stress in the fuel rods. Correction of the input error doubled the bending stress, resulting in negative margins. This led to the conclusion that stresses in the fuel rod cladding exceeds the licensing basis limits for the NAC-UMS and MAGNASTOR® storage systems.

As part of its revised MOE, NAC performed analyses to assess the potential for fuel rod yielding in fuel assemblies with partially damaged fuel grids in a non-mechanistic tip-over event. The analysis of stress in the fuel rods, Calculation No: 71160-2049, Rev.3, “Fuel Rod Evaluation for the MAGNASTOR® Storage Tip-Over Accident,” is a bounding analysis which includes fuel rod types in all NAC-UMS, MAGNASTOR® concrete and MSO storage systems.

The revised MOE represented the tip-over loading as a combination of the peak acceleration from the response spectrum corresponding to the acceleration time history (ATH) at the top of the fuel basket from an LS-DYNA tip-over analysis and applying this, conservatively, to the entire length of the fuel rod using a dynamic load factor (DLF) based on the modal analysis of the selected fuel rod.

The results of this revised MOE demonstrated that the stress in the fuel rod cladding remains below the rod material allowable yield stress in a non-mechanistic tip-over event and supports the existing criteria of less than or equal to 60 inches of unsupported rod length (i.e., loss of grid strap support), allowing fuel assemblies with grid damage to not require placement into damaged fuel cans.

NAC concluded that the deficiency does not impact the safety functions of the cask in the MAGNASTOR® concrete and MSO systems. Nor does it affect any other NAC designed storage system.

4.2 Evaluation

This SER documents the staff's evaluation of NAC's revised analysis, the revised MOE, and staff's conclusions, based on staff's review of the information provided in the application which includes the FSAR, Revision 23C, and the new calculation and is the basis for the revised MOE in Amendment No. 14 to the CoC.

In its analysis, the applicant has grouped the PWR and BWR fuel assemblies into separate groups to model a fuel rod with properties that bound the fuel rod characteristics of each group. Tables 4.0-1 and F.2-1 in calculation number 71160-2049, Rev.3 lists the PWR and BWR fuel rod data, respectively, addressed in the calculation. The acceleration from the tipover analysis in LS-DYNA is represented at the top of the basket in the form of an ATH. The acceleration magnitude for the ANSYS analysis is the peak acceleration of the response spectra representation of the ATH. The peak acceleration is amplified by using a DLF, computed from an ANSYS modal analysis of the fuel rod, and a response spectrum solution of the ATH data.

In the static ANSYS analysis an initial acceleration of 30g and 45g is applied at the top of the fuel basket for the PWR and BWR fuel assemblies, respectively, as bounding 'g' values for the new analysis which is uniformly applied over the length of the fuel rod. The 'g' values used envelope the 'g' value at the top of the fuel basket for all systems (NAC-UMS, MAGNASTOR® concrete and MSO). For the PWR assembly a grid is considered missing, leading to a maximum unsupported length of 60 inches between grids, while for the BWR analysis all the grids are intact. A DLF is used to convert the applied 'g' load into an equivalent static load to be applied uniformly across the length of the fuel rod.

4.3 Methodology

Staff reviewed the methodology presented in Calculation No 71160-2049, Page 6 of 22. The staff finds the approach of using the peak acceleration from the response spectra derived from the LS-DYNA ATH at the top of the basket in a tip-over event and its application to the entire fuel rod an acceptable analytical practice. This acceleration is further amplified by the DLF to account for the dynamic effect of the load. The staff finds this method acceptable because it is consistent with standard analytical practices used for capturing the transient effects of a suddenly applied load in an equivalent static analysis. The staff concludes that the revised MOE is acceptable.

4.4 Selection of Bounding Cases and Assumptions

The staff reviewed the selection of the fuel rods in the revised MOE because it used more specific information than the prior enveloped condition. The applicant provided detailed explanations about the selection of the bounding cases of the fuel rods used in the analysis, explaining how the bounding set was derived from the set of BWR and PWR fuel rods that are to be accommodated in the different variations of casks available for the MAGNASTOR® concrete and MSO designs. The staff reviewed the information provided under Docket No. 72-1031 for CoC No. 1031 in the application, as a basis for selecting the bounding cases considering the different size, mass, and the center of gravity of the different cask designs. The staff finds the basis to be appropriate because it is consistent with the design configurations previously approved by the NRC staff in CoC No. 1031, Amendment No. 0 (ML090350509). Based on these findings, the staff concludes that the bounding cases identified for analysis are acceptable.

The staff reviewed the inputs and assumptions used by NAC in its analysis. In addition, the staff reviewed the information NAC provided in its application as justification for its assumptions and finds that the assumptions are appropriate, and that the modeling of the fuel rods are consistent with NAC's design. The NRC staff concludes that the revised inputs and assumptions are adequate, because the revised MOE used appropriate fuel rod stress values for each of the three claddings. Based on these findings, the staff concludes that the assumptions are acceptable for use in the stress analysis of the fuel rods.

4.5 Finite Element Models and Model Properties

The staff reviewed the finite element model (FEM) of the fuel rods considered in the applicant's analysis and their associated sectional and material properties. Table 4.0-1 in Calculation No. 71160-2049 lists the 33 PWR fuel rod data and Table F.2-1 lists the 27 BWR fuel rod data considered in the analysis. From these lists, bounding fuel rods were selected based on their response to a vertical concrete transporter tip-over condition. A single rod is analyzed for each type of fuel assembly used with the dry cask storage systems. An ANSYS finite element analysis is performed to evaluate the PWR high burnup fuel rod for the MAGNASTOR® cask tip-over accident. The FEM using beam elements represents a single fuel rod with a nominal rod diameter and cladding thickness. For the Zirc-4, ZIRLO™, and M5**®** cladding, the outside diameter of the cladding is reduced to consider an oxide layer.

The fuel rod is oriented along the y-direction, with lateral constraints (x-direction) applied to the model at the intact grid locations. Gap elements are added to the model along the fuel rod in the region of the 60-inch unsupported span between grids 5 and 8. The gap size is set to limit the amount of fuel rod bending based on clearances between adjacent fuel rods and between the fuel rod and basket. A typical fuel rod model is shown in Calculation No 71160-2049, Figure 6.0-1, Page 17 of 22. The details of the model properties used in the analysis of the different rods are presented in Section 6.1, "Section Properties," on Page 12 of 22, and Section 6.2, "Material Properties," Page 13 of 22, of Calculation No 71160-2049.

The staff finds that the boundary conditions of the FEM adequately represent the actual constraints and gaps experienced by the fuel rod during bending. The material properties are adequately captured by the model and the rigidity offered by the fuel pellets is conservatively ignored because it decreases the actual rigidity of the cladding, while the weight is captured by increasing the density of the cladding. Based on these findings the staff concludes that the FEM will adequately capture the fuel rod response under the applied loading.

4.5 Application of Load

The staff reviewed how the applicant has applied the acceleration resulting from the tip-over to the model so that the response of the model captures the effect of impulsive load over the period of the acceleration. Because a static analysis is performed using ANSYS to evaluate the fuel rod, the effect of the transient nature of the load is accomplished by using a DLF. The DLF amplifies the peak acceleration at the top of the basket. The factored peak acceleration is applied uniformly to all beam elements along the length of the fuel rod as a static force, which is conservative for a tip-over event. Details of the fuel rod DLF calculation and results for the Zirc-4/ZIRLO™ model are given in Appendix C for the concrete cask number 8 (CC8) cask and Appendix D for the CC1 cask in Calculation No. 71160-2049, Rev. 1. The value of the DLF is dependent on the fuel rod modal frequencies and the shape and duration of the acceleration time history. The peak acceleration at the top of the basket for CC8 and CC1 are 25.8g and 26.6g respectively. The resulting accelerations and DLF's from Appendix C and D are summarized in Table 6.4-1 in Calculation No. 71160-2049.

The staff finds that the applicant has appropriately used standard engineering practices to convert the ATH from the LS-DYNA analysis to a response spectrum and used the peak acceleration to compute the loads. The DLF factors were appropriately computed to retain the modal participation of all masses.

Based on these findings the staff concludes that the applicant has appropriately introduced the transient loads into the static analysis for computation of bending stress in the fuel cladding.

4.6 Stresses in the Cladding

The staff reviewed the results of the analysis presented in Table 8.0-1 in Calculation No. 71160-2049. The factor of safety for all types of cladding analyzed are greater than 1.0. Because yield stress decreases with increases in temperature, stresses are evaluated against the cladding yield stress at the maximum permitted fuel temperature of 752°F (400°C) to compute factors of safety.

In SAR section 3.8.4, the applicant provided yield stress values for Zircaloy-4, ZIRLO™, and M5® and associated technical references to include PNNL-17700 "PNNL Stress/Strain Correlation for Zircaloy." The staff notes that use of mechanical property models from PNNL-17700 for Zircaloy-4 and ZIRLO™ with additional references for M5® is consistent with the guidance in NUREG-2215, "Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities," Section 8.5.15.2.2, "Cladding Mechanical Properties." The staff reviewed the cladding material properties and applicable technical references and found them to be acceptable. The staff reviewed NAC's proposed yield stress values and concluded that the values chosen by NAC are bounding for the cladding alloys in the allowable SNF contents.

Based on staff's review of the results of NAC's stress calculations for the fuel rod cladding, the staff concludes that the applicant's analysis in the revised MOE corrects the identified deficiency and using material specific stress values. Staff's conclusion is based on the fact that the fuel rod cladding material properties more closely represent the different fuel rod claddings authorized for storage in the MAGNASTOR® concrete and MSO dry cask storage systems.

4.7 Potential Impact of Revised Method of Evaluation on Amendments 0–13

NAC requested a revision to the CoC No.1031 for the NAC MAGNASTOR® Cask System that integrates TS changes in Amendment No. 14 with the TS changes in Amendment Nos. 0 through 13.

The staff reviewed the changes sought in Amendments Nos. 0 through 9 and finds that NAC redefined the cask and the cask lid as separate components of the storage cask. In doing so, NAC separated the concrete design criteria for both components. The staff concluded that this change does not impact the TSC and its contents and hence has no structural impact on the fuel rod stress analysis.

In Amendment No. 10, NAC introduced a new storage cask for the MAGNASTOR® system called the MSO. The staff review focused on the MSO which is another variant that can be used in lieu of one of the MAGNASTOR® concrete storage cask variants providing additional structural strength and shielding to the previously approved TSCs for spent fuel. No evaluation was made of the TSC and its contents and NAC acknowledged that the bounding acceleration of 60g for the side drop model used in the tipover analysis for Amendment 10 for the TSC and contents is greater than the decelerations determined for the revised MOE. In the revised MOE, the analysis for the fuel rods in Amendment No. 14 impacts the prior evaluation of the MSO fuel rods. In the analysis of the fuel rods in the revised MOE, NAC used the ATH from NAC Calculation 30082-2605, Rev. 1, "Tip-Over Analysis for the MAGNASTOR Metal Storage OverPack (MSO)," and the DLF to determine the calculated ‘g’ loads on the fuel rods. NAC determined that the resulting calculated ‘g’ values at the top of the fuel basket for both PWR and BWR fuel rods are less than (bounded) by the design-basis ‘g’ values of 60g that were used to determine the fuel rod stresses. The staff reviewed NAC’s analysis and agrees that the stresses calculated for the design-basis 60g side drop model in the tipover analysis bounds the analysis in the revised MOE.

In Amendment No. 11, the applicant made the following changes to the storage cask design:

- add a seventh concrete overpack (CC7) and a lightweight MAGNASTOR® transfer cask (LMTC)
- increase the maximum heat load for the system when using CC7 and the LMTC new loading patterns
- add new 81-assembly and 89-assembly BWR spent fuel basket designs, and associated loading patterns
- remove existing 87-assembly and 82-assembly BWR basket designs
- add a new BWR damaged fuel basket design with a capacity of up to 81 undamaged BWR fuel assemblies
- add a new damaged fuel can for BWR fuel

In its application for Amendment No. 11, NAC performed calculations to demonstrate that the resulting storage cask complied with 10 CFR Part 72 requirements, the staff’s SER (ML23250A360) documents staff’s approval of the amendment, specifically in Table 4.3 of the referenced Calculation in the SER. The FSAR Table 4.3 presents the evaluation of CC7 tip-over analysis results. The results show that the ‘g’ value at the top of the fuel basket is enveloped by the ‘g’ values used in the new calculation.

Neither Amendment No. 12 nor Amendment No. 13 involved analyses for the fuel rods, therefore an analysis of the licensing basis for stresses in the fuel rods for these two amendments is not necessary.

4.8 Conclusion

The staff concludes that the revised MOE correcting the deficiency in the ANSYS model of the spent fuel rods demonstrates that for the MAGNASTOR® concrete and MSO dry cask systems, the stress in the fuel rods in a non-mechanistic tip-over complies with the structural regulatory licensing basis for both Amendment No. 14 and revision to Amendment Nos. 0-13.

5.0 THERMAL EVALUATION

5.1 Introduction

The thermal review of Amendment No. 14 and revisions to Amendment Nos. 0-13 for the MAGNASTOR® cask system ensures that the cask components and fuel material temperatures will remain within the allowable values under normal, off-normal, and accident conditions. This review includes confirmation that the fuel cladding temperatures for fuel assemblies stored in the MAGNASTOR® cask system will be maintained below specified limits throughout the storage period to protect the cladding against degradation that could lead to gross ruptures. This portion of the review also confirms that the cask thermal design has been evaluated using acceptable analytical techniques and/or testing methods.

This review was conducted under the regulations described in 10 CFR 72.236, which identify the specific requirements for the regulatory approval, fabrication, and operation of spent fuel storage cask designs. The unique characteristics of the spent fuel to be stored in the MAGNASTOR® cask system are identified, as required by 10 CFR 72.236(a), so that the design basis and the design criteria that must be provided for the structures, systems, and components (SSCs) important to safety can be assessed under the requirements of 10 CFR 72.236(b). This application was also reviewed to determine whether the MAGNASTOR® design addresses the acceptance criteria listed in Sections 3, 5 and 16 of NUREG-2215.

The following change proposed under Amendment No. 14 to the MAGNASTOR® cask system is applicable to the thermal evaluation:

- The applicant is requesting that limiting condition for operation (LCO) 3.1.2 and the associated FSAR Bases be revised to provide system users clarification on inlet and outlet vent blockage and surveillance requirements. The applicant is requesting that the changes being proposed via this amendment be included in those TS changes for amendments 0 through 13 via issuance of a CoC revisions. This is the only change that affects the heat transfer through the MAGNASTOR® cask system.

5.2 Evaluation

The applicant used the ANSYS FLUENT computer-based analysis program to evaluate the thermal performance of the MAGNASTOR® spent fuel storage system. ANSYS FLUENT is a finite volume computational fluid dynamics (CFD) program with capabilities to predict fluid flow and heat transfer phenomena in two and three dimensions. The staff had reviewed the applicant's description of the MAGNASTOR® storage system thermal model in previous amendments and found the description of the model was consistent with guidance provided in NUREG-2215, Section 5.5.4 (Analytical Methods, Models, and Calculations). The staff concludes that the description of the thermal model is acceptable because the model of the storage cask is the same one that NAC used in its previous analyses to which NAC added the appropriate amount of material to block the vents. Therefore, the description is consistent with NUREG-2215, and satisfies the requirements of 10 CFR 72.236(b), 10 CFR 72.236(f), 10 CFR 72.236(g), and 10 CFR 72.236(h).

To justify the change applicable to the thermal evaluation (as described in Section 5.1 above), the applicant evaluated a partial blockage of air inlet and outlet vents, which is an off-normal event. For the partial blockage of air vents, the air vents are modified in the thermal model to permit air flow through half of the air vent area. The applicant used the preferential loading pattern (Pattern Z, as described in the FSAR) to perform the half-blocked air vents analysis because it is the bounding heat load pattern (per evaluations provided in the FSAR). The temperatures of cask components for the analysis are provided in FSAR Section 4.11.3. The staff reviewed the calculations results provided in the FSAR and results obtained from the thermal model to verify consistency between calculated and reported results. The staff verified that all component temperatures remained below the allowable limits described in the FSAR for off-normal conditions of storage for this event. Based on these results, the staff concludes that revision of LCO 3.1.2 and the FSAR associated basis (as described in the amendment request), is acceptable.

The staff reviewed the applicant's thermal evaluation during off-normal conditions (half-blocked air vents). Based on the information provided in the application regarding the applicant's thermal evaluation, the staff determined that the application is consistent with guidance provided in NUREG-2215, Section 4.4.4 (Analytical Methods, Models, and Calculations) and therefore, meets the requirements of 10 CFR 72.236(f).

5.3 Confirmatory Analyses

The staff reviewed the applicant's thermal models used in the analysis, checking the code input in the calculation packages submitted and confirming that the proper material properties and boundary conditions were used. The staff verified that the applicant's selected code models and assumptions were adequate for the flow and heat transfer characteristics prevailing in the MAGNASTOR® geometry for the analyzed conditions. In addition, the staff performed appropriate sensitivity analysis calculations to verify that applicant's predicted results provide bounding predictions for the event analyzed in the application. Based on the review of analysis provided and performed sensitivity calculations, the staff determined that the applicant's thermal model and analysis are acceptable and bounding.

5.4 Evaluation Findings

F5.1 Chapter 2 of the FSAR describes SSCs important to safety to enable an evaluation of their thermal effectiveness. Cask SSCs important to safety remain within their operating temperature ranges.

F5.2 The MAGNASTOR® storage system is designed with a heat removal capability having verifiability and reliability consistent with its importance to safety. The cask system (TSC, transfer cask and concrete overpack) is designed to provide adequate heat removal capacity without active cooling systems.

F5.3 The spent fuel cladding is protected against degradation leading to gross ruptures under long-term storage by maintaining cladding temperatures below 752 °F (400 °C). Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for future processing or disposal.

F5.4 The spent fuel cladding is protected against degradation leading to gross ruptures under off-normal and accident conditions by maintaining cladding temperatures below 1058 °F

(570 °C). Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for future processing or disposal.

F5.5 The staff finds that the thermal design of the MAGNASTOR® storage system complies with the design requirements in 10 CFR 72.236 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the cask will allow for safe storage of spent nuclear fuel. This finding is reached based on a review that considered the regulation itself, appropriate regulatory guidance, applicable codes and standards, and accepted engineering practices.

6.0 SHIELDING EVALUATION

NAC did not request any changes to the shielding design, contents, or analyses in either Amendment No. 14 or revision to Amendment Nos. 0-13. Because the there are no changes to the shielding design and the NAC demonstrated that the calculated yield stress in the cladding is below the cladding yield stress, there is no reconfiguration of the fuel, therefore the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the storage system remains in compliance with 10 CFR Part 72.

7.0 CRITICALITY EVALUATION

NAC did not request any changes to the criticality design, contents, or analyses in either Amendment No. 14 or revision to Amendment Nos. 0-13. Because there are no changes to the criticality design or contents and NAC demonstrated that the calculated yield stress in the cladding is below the cladding yield stress, there is no reconfiguration of the fuel, therefore the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the storage system remains in compliance with 10 CFR Part 72.

8.0 MATERIALS EVALUATION

As discussed in Section 4.6, above, NAC revised the yield stresses for each of the three claddings authorized for storage in the MAGNASTOR® dry storage system. In addition, NAC requested removal of the reference to Type II Portland cement in the description of the CoC. Because the concrete storage cask body is governed by the American Concrete Institute codes in Section 4.2 of Technical Specifications, Appendix A, which are not changing, the concrete will still have the same performance and testing to ensure it meets the American Concrete Institute codes.

9.0 CONFINEMENT EVALUATION

In MAGNASTOR® Amendment No. 14 or revision to Amendment Nos. 0-13, the changes proposed in the SAR did not change the confinement design/function of the TSC, which is tested to leaktight criteria, in accordance with ANSI N14.5, “American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials.”

Because the design/function of the confinement system of the TSC did not accrue any changes, the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the TSC remains in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria continue to be satisfied.

10.0. RADIATION PROTECTION EVALUATION FOR DRY STORAGE SYSTEMS

Because there was no change to the shielding evaluation in chapter 6 above, the average dose rates around the loaded storage cask do not change. Because there is no change in the average dose rates and changes requested in Amendment No. 14 and revision to Amendment Nos. 0-13 do not affect the radiation protection components of the storage system, therefore the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the storage system remains in compliance with 10 CFR Part 72.

11.0 OPERATION PROCEDURES AND SYSTEMS EVALUATION

There were no requested changes to the operating procedures and none of the changes in this amendment affect the operating procedures section. Because there were no changes to the storage system or its contents, the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the TSC remains in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria continue to be satisfied.

12.0 CONDUCT OF OPERATIONS

NAC did not propose any changes to the acceptance tests or maintenance program in Amendment No. 14 or revision to Amendment Nos. 0-13. Because there were no changes to the acceptance tests or maintenance program, the NRC staff finds that the safety and regulatory compliance conclusions remain unchanged, thus the TSC remains in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria continue to be satisfied.

15.0 QUALITY ASSURANCE EVALUATION

There were no requested changes to NAC's quality assurance program and none of the changes requested affect the quality assurance program.

16.0 ACCIDENT ANALYSES

NAC made minor changes to Section 12.1.2.4, "Corrective Actions," for the off-normal event "Blockage of One-Half of the Air Inlets," because NAC demonstrated in its thermal analysis provided in the Revision 23C of the FSAR that temperatures remain below allowable temperatures (see chapter 5, "Thermal Evaluation," above) when half of the air inlet vents are blocked, NAC revised the corrective action to state that no immediate action is needed because the heat removal capability is still functioning, however debris blocking the vents should be cleared ensure continued operability of the heat removal to system.

The staff reviewed NAC's proposed change in chapter 12 of the SAR and determined that the change in Section 12.1.2.4 is consistent with the revised storage cask design bases and the technical analysis in the revised thermal evaluation. Therefore, the proposed change for Amendment No. 14 and revision to Amendment Nos. 0-13 requested by NAC do not alter the staff's previous evaluation of the accident analyses for the MAGNASTOR® system, thus the storage system remains in compliance with 10 CFR Part 72.

17.0 TECHNICAL SPECIFICATIONS EVALUATIONS

NAC requested two changes to the technical specifications, clarification that damaged or missing grid spacers only applies to PWR fuel assemblies and the changes in LCO 3.1.2 in Appendix A that are discussed in chapter 5, Thermal Evaluation, above.

18 CONCLUSION

Based on the statements and representations provided by the applicant in its amendment application, as supplemented, the staff concludes that the changes described above to the MAGNASTOR® storage system do not affect the ability of the cask system to meet the requirements of 10 CFR Part 72. Amendment No. 14 and revision to Amendment Nos. 0-13 for the MAGNASTOR® storage system should be approved.

Issued with certificate of compliance No. 1031, Amendment No. 14 and revision to Amendment Nos. 0-13 on ___draft______.