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

PRELIMINARY SAFETY EVALUATION REPORT
NAC INTERNATIONAL, INC.
MAGNASTOR® STORAGE SYSTEM
DOCKET NO. 72-1031
AMENDMENT NO. 2, REVISION NO. 1

Summary

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of a revision to Amendment No. 2 to Certificate of Compliance No. 1031 for the Modular Advanced Generation Nuclear All-purpose STORage (MAGNASTOR®) spent fuel dry cask storage system. By application dated June 20, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14174B095), as supplemented January 14, 2015 (ADAMS Accession No. ML15016A047), the cask vendor, NAC International, Inc. (hereafter, NAC), submitted a request to the NRC in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 72.244 to revise Certificate of Compliance No. 1031. NAC requested the following changes:

- Revise decay times in Technical Specification, Appendix B, Table B2-5 for minimum additional decay time required for the spent fuel when the fuel contains nonfuel hardware and expansion to include the use of the three-zone preferential loading pattern with nonfuel hardware, and
- Correct typographical errors in two required minimum actual areal boron densities in Technical Specification 4.1.1(a).

This revised certificate of compliance, when codified through rulemaking, will be denoted as Amendment No. 2, Revision No. 1, to Certificate of Compliance No. 1031. As a revision, the certificate of compliance will supersede the previous version of the certificate, including the technical specifications, that was effective on January 30, 2012, (ADAMS Accession No. ML12144A070) in its entirety. The applicant has requested a revision in lieu of a new amendment utilizing the following justifications:

- There is only one general licensee using casks certified as Amendment No. 2 to Certificate of Compliance No. 1031 and it does not object to this revision;
- the requested changes are minor;
- no changes are being made to the physical design of the MAGNASTOR® storage system via this revision;
- no new systems, structures, or components (SSCs) are requested to be added to Certificate of Compliance No. 1031, via this revision; and
- the requested changes are applicable to Certificate of Compliance No. 1031, Amendment No. 2, in their entirety.

The staff has provided an additional CoC condition that provides a general licensee up to 180 days from the effective date of the revision to implement any changes authorized by this revision and to update their 10 CFR 72.212 evaluation required by implementation of the revision.

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

The NRC staff determined that the areas of the previous safety evaluation (ADAMS Accession No. ML120320247) that are not affected by this amendment include: structural, confinement, thermal, criticality, materials, operating procedures, acceptance test & maintenance, radiation protection, accident analyses, and quality assurance.

1.0 GENERAL DESCRIPTION

The revisions requested by NAC do not affect the system general description and do not alter the staff’s previous evaluation of the general description of the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

2.0 PRINCIPAL DESIGN CRITERIA

The revisions requested by NAC do not affect the principal design criteria and do not alter the staff’s previous evaluation of the principal design criteria for the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

3.0 STRUCTURAL EVALUATION

The revisions requested by NAC do not affect the structural performance and do no alter the staff’s previous structural evaluation of the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

4.0 THERMAL EVALUATION

The revisions requested by NAC do not affect the thermal performance and do not alter the staff’s previous thermal evaluation for the MAGNASTOR® cask system since the total decay heat of the system remains unchanged. Therefore, the staff did not reevaluate this area for this revision request.

5.0 SHIELDING EVALUATION

The objective of this review is to verify that the proposed revision to the MAGNASTOR® design meets the requirements of 10 CFR 72.104 and 10 CFR 72.106 under normal, off-normal and accident conditions. The proposed change corrects discrepancies in Table B2-5, "Additional SNF Assembly Cool Time Required to Load NONFUEL HARDWARE," which contained non-conservative additional cooling times for fuel assemblies loaded with rod cluster control assemblies (RCCAs, also known as control element assemblies [CEAs]). In addition, the applicant requested Table B2-5 be expanded to cover the use of the three-zone preferential loading pattern with nonfuel hardware.

The staff’s shielding review evaluated the proposed change requested in this revision in conjunction with the findings from previous staff analyses to determine whether, with the requested changes, the system continues to provide adequate protection from the radioactive contents of the fuel within the system. This review evaluated the methods and calculations

employed by NAC to determine the expected gamma and neutron radiation at locations near the cask surface and at specific distances away from the cask.

5.1 Shielding Design Description

This revision request does not involve changes to the shielding design for the storage system.

5.2 Source Specification

The source term for the bounding Combustion Engineering PWR fuel (CE 16×16) is unchanged by this revision request.

5.3 Shielding Model

This revision request does not involve changes to the shielding design of the MAGNASTOR® dry storage system.

5.4 Shielding Evaluation

As stated in the June 5, 2014, deficiency letter from NAC (ADAMS Accession No. ML14160A856), Table B2-5, "Additional Fuel Assembly Cool Time Required to Load PWR Nonfuel Hardware," the table contained non-conservative additional cooling times for fuel assemblies loaded with RCCAs. This was due to the added heat loads of nine RCCAs being distributed across the entire basket instead of distributed to just the nine fuel bundles in which the RCCAs were to be placed. As part of the review for this deficiency, the applicant also requested expansion of Table B2-5 to include additional cooling times for nonfuel hardware in each zone of the three-zone preferential loading pattern. The applicant made adjustments to the heat loads contained in Table B2-5 to correct the deficiency and expand for use in the preferential loading pattern resulting in a new Table B2-5 which is included in the proposed technical specifications. The applicant's analysis indicated that the proposed additional cooling times for fuel assemblies containing nonfuel hardware reduce the fuel assemblies decay heat to account for the decay heat from the nonfuel hardware and still maintain the decay heat in any individual cell below the decay heat limits in the technical specifications, whether for uniform loading or preferential loading.

NAC proposed changes to the additional cooling times for RCCAs and some burnable poison absorber assemblies (BPAAs)/hafnium absorber assemblies (HFRAs). NAC utilized previously calculated quantities of activated metal in the control components to re-evaluate the minimum decay time to achieve the maximum decay heat in a fuel assembly containing control components. Results of these calculations are shown in Tables 5.8.5-7 for BPAAs and 5.8.6-3 for RCCAs for uniform loading and Table 5.8.7-2 for three-zone preferential loading, as presented in the supplement to the June 5, 2014 letter, dated June 13, 2014 (ADAMS Accession No. ML14170A070). According to these results, the additional dose rate on the sides of the concrete and transfer casks does not affect the maximum dose rates. At the concrete cask inlets and transfer cask bottom, loading of RCCAs increases the maximum dose rates. According to the applicant, however, an increase in the spent fuel assembly cool time, as shown in Table 5.8.6-3, provides the necessary margin to accommodate the increased dose rates at the concrete cask inlets and transfer cask bottom from loading RCCAs. The applicant calculated the additional doses resulting from including nonfuel hardware and determined that the total dose from nonfuel hardware and spent fuel were still below the limits specified in the technical specifications. Nevertheless, the applicant proposed longer cooling time for certain spent fuel (see Technical Specification Table B2-5) in order to maintain the large safety margin.

5.4.1 Confirmatory Review and Analysis

The staff reviewed the applicant's shielding analysis and found it acceptable because the maximum dose rates with the revision continue to meet the limits defined by 10 CFR Part 72, and the decay heat from fuel assemblies containing nonfuel hardware will meet the decay heat limits in the technical specifications for each individual basket cell. The staff reviewed the radiation shielding evaluations, including the calculations of the sources, and the dose rates for the transfer cask and the concrete casks. The staff also performed confirmatory analyses of the dose rates for the transfer and storage casks. Based upon this review and analyses, the staff concludes that the applicant has demonstrated that the MAGNASTOR® dry cask storage system meets the radiation protection requirements of 10 CFR 72.104, 72.126, and 72.128.

5.5 Evaluation Findings

Based on the NRC staff's review of information provided for the MAGNASTOR® application, the staff finds the following:

F5.1 Chapter 5 of the MAGNASTOR® safety analysis report describes shielding structures, systems, and components important to safety in sufficient detail to allow evaluation of their effectiveness.

F5.2 Chapter 5 of the MAGNASTOR® safety analysis report provides reasonable assurance that the radiation shielding features are sufficient to meet the radiation protection requirements of 10 CFR Part 20, 10 CFR 72.104, and 10 CFR 72.106.

F5.3 Operational restrictions to meet dose and ALARA requirements in 10 CFR Part 20, 10 CFR 72.104, and 10 CFR 72.106 are the responsibility of the general licensee. The MAGNASTOR® shielding features are designed to assist in meeting these requirements.

Based upon its review, the staff has reasonable assurance that the design of the shielding system for the MAGNASTOR® system, including the concrete cask, the transfer cask, and the canister, are in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the shielding and radiation protection design features provides reasonable assurance that the MAGNASTOR® system will provide safe storage of spent fuel in accordance with 10 CFR 72.236(d). This finding is based on a review that considered the regulation itself, the appropriate regulatory guides, applicable codes and standards, the applicant's analyses, the staff's confirmatory analyses, and acceptable engineering practices.

6.0 CRITICALITY EVALUATION

The revisions requested by NAC do not affect the criticality analyses of the system and do not alter the staff's previous criticality evaluation of the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

7.0 CONFINEMENT EVALUATION

The revisions requested by NAC do not affect the confinement system and do not alter the staff's previous confinement evaluation of the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

8.0 MATERIALS EVALUATION

The revisions requested by NAC do not affect the materials of the system and do not alter the staff's previous materials evaluation of the MAGNASTOR® system. Therefore, the staff did not reevaluate this area for this revision request.

9.0 OPERATING PROCEDURES EVALUATION

The revisions requested by NAC do not affect the operating procedures of the system and do not alter the staff's previous operating procedures evaluation of the MAGNASTOR® system. Therefore, the staff did not reevaluate this area for this revision request.

10.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

The revisions requested by NAC do not affect the acceptance tests and maintenance programs of the system and do not alter the staff's previous evaluation of the acceptance tests and maintenance programs of the MAGNASTOR® system. Therefore, the staff did not reevaluate this area for this revision request.

11.0 RADIATION PROTECTION EVALUATION

The revisions requested by NAC do not affect the radiation protection components of the system and do not alter the staff's previous evaluation of radiation protection of the MAGNASTOR® system. Therefore, the staff did not reevaluate this area for this revision request.

12.0 ACCIDENT ANALYSIS EVALUATION

The revisions requested by NAC do not affect the accident analyses of this system and do not alter the staff's previous evaluation of the accident analyses of the MAGNASTOR® system, as all other accidents are bounded by the previous accident analyses. Therefore, the staff did not reevaluate this area for this revision request.

13.0 TECHNICAL SPECIFICATIONS AND OPERATING CONTROLS AND LIMITS EVALUATION

The applicant requested technical specification changes to:

- correct non-conservative limits in Table B2-5, "Additional SNF Assembly Cool Time Required to Load NONFUEL HARDWARE," for additional cooling times for fuel assemblies loaded with nonfuel hardware and expansion of Table B2-5 to include a three-zone preferential loading patterns for fuel assemblies with nonfuel hardware, and
- an editorial change in Appendix A of the technical specifications to revise the minimum required ^{10}B actual areal density from 0.334 g/cm^2 to 0.0334 g/cm^2 for both borated aluminum alloy and borated metal matrix composite (MMC) for PWR fuel baskets.

The revision to this CoC also incorporates a condition that allows the previous version of this certificate, Amendment No. 2, dated January 30, 2012, to continue to be used for 180 days from the effective date of the revised certificate in order to provide general licensees time to implement any changes authorized by this revision and to update the 10 CFR 72.212 evaluation required by implementation of this revision. The NRC has determined that, because CoCs approved under CoC 1031, Amendment No. 2, have previously been found to comply with the

necessary regulations, allowing this implementation period, during which general licensees must be in compliance with either CoC 1031, Amendment No. 2, or CoC 1031 Amendment No. 2, Revision 1, continues to ensure protection of public health and safety.

13.1 Fuel Specification changes

The applicant requested revision of the values in Technical Specification Appendix B, Table B2-5 in for additional cooling time for fuel assemblies containing nonfuel hardware. The proposed revisions corrected errors in the uniform loading decay heat load for nonfuel hardware and expand Table B2-5 to include additional cooling times for nonfuel hardware in the three-zone preferential loading pattern.

Table B2-5 has been revised to include the following table:

			Three-Zone		
Assy		**Uniform**	**A**	**B**	**C**
CE 14x14	BPRA/HFRA	--	--	--	--
	GTPD/NSA	--	--	--	--
	RCC	0.2	0.2	0.1	0.2
WE 14x14	BPRA/HFRA	0.5	0.5	0.2	0.7
	GTPD/NSA	0.1	0.1	0.1	0.1
	RCC	2.0	2.3	0.7	4.1
WE 15x15	BPRA/HFRA	0.5	0.6	0.2	0.8
	GTPD/NSA	0.1	0.1	0.1	0.1
	RCC	3.1	3.4	1.5	4.5
B&W 15x15	BPRA/HFRA	0.1	0.1	0.1	0.1
	GTPD/NSA	0.1	0.1	0.1	0.1
	RCC	0.2	0.2	0.1	0.2
CE 16x16	BPRA/HFRA	--	--	--	--
	GTPD/NSA	--	--	--	--
	RCC	0.2	0.2	0.1	0.3
WE 17x17	BPRA/HFRA	0.5	0.6	0.2	0.7
	GTPD/NSA	0.1	0.1	0.1	0.1
	RCC	2.9	3.3	1.4	4.3
B&W 17x17	BPRA/HFRA	0.1	0.1	0.1	0.1
	GTPD/NSA	0.1	0.1	0.1	0.1
	RCC	0.2	0.2	0.1	0.2

13.2 Minimum ^{10}B loading in the neutron absorber material

By application dated March 22, 2010 (ADAMS Accession No. ML112630346), as supplemented March 30 (ADAMS Accession No. ML112630345), March 31 (ADAMS Accession No. ML100950172), June 8 (ADAMS Accession No. ML101610085), July 1 (ADAMS Accession No. ML102880325), November 10 (ADAMS Accession No. ML103190427), and November 19, 2010 (ADAMS Accession No. ML103260461), April 22 (ADAMS Accession No. ML11115A146), and May 17, 2011 (ADAMS Accession No. ML11143A101), NAC requested several changes to Certificate of Compliance No. 1031, one of which is the addition of various ^{10}B areal densities for use with PWR and BWR baskets. These changes in boron density were incorporated in the certificate as Amendment No. 2.

In its application dated March 22, 2010, NAC performed a criticality analysis for PWR baskets and took 90% credit for the ^{10}B in the borated aluminum alloy and borated MMC plates. The effective ^{10}B density (90% of actual ^{10}B density) that was used in the criticality evaluation was 0.036 g/cm^2, 0.030 g/cm^2, and 0.027 g/cm^2 to ensure criticality safety. Table 13-1 (Table 6.1.1-5 in NAC's application) translated the effective areal density of neutron absorber content to actual required areal density using 90% credit.

Table 13-1: Effective Areal Density as a Function of Absorber Credit

	Effective ^{10}B g/cm^2	75% Credit ^{10}B g/cm^2	90% Credit ^{10}B g/cm^2
PWR	0.036	0.048	0.040
	0.030	0.040	0.0334
	0.027	0.036	0.03
BWR	0.027	0.036	0.030
	0.0225	0.030	0.025
	0.020	0.0267	0.0223

Since the NAC criticality evaluation and the NRC staff's safety evaluation report (ADAMS Accession No. ML120320247) both indicate that the effective areal density used was 0.030 ^{10}B g/cm^2, the NRC staff concludes that the value stipulated in LCO 4.1.1(a) of 0.334 ^{10}B g/cm^2 is a typographical error and should be 0.0334 ^{10}B g/cm^2.

13.2 Evaluation Findings

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

14.0 QUALITY ASSURANCE EVALUATION

The revisions requested by NAC do not affect the quality assurance program for the system and do not alter the staff's previous quality assurance evaluation of the of the MAGNASTOR® cask system. Therefore, the staff did not reevaluate this area for this revision request.

15.0 CONCLUSION

The staff performed a detailed safety evaluation of the application for Amendment No. 2, Revision No. 1 to Certificate of Compliance No. 1031 for the MAGNASTOR® storage system. The staff performed the review in accordance with the guidance in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," Rev. 1, dated July 2010. Based on the statements and representations contained in the application, as supplemented, and the conditions established in the certificate of compliance and its appendices (technical specifications), the staff concludes that the MAGNASTOR® System, as revised, meets the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1031, Amendment No. 2, Revision No. 1, on

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