October 10, 2008

Mr. Anthony Patko
Director, Licensing
Engineering
NAC International
3930 East Jones Bridge Road, Suite 200
Norcross, GA 30092

SUBJECT: REVISION 49 OF CERTIFICATE OF COMPLIANCE NO. 9225 FOR THE MODEL NO. NAC-LWT PACKAGE

Dear Mr. Patko:

By letter dated January 25, 2008, as supplemented July 17 and August 20, 2008, NAC International (NAC) submitted a revised application in accordance with 10 CFR Part 71 for an amendment to Certificate of Compliance No. 9225 for the Model No. NAC-LWT package to incorporate PWR mixed oxide (MOX) fuel rods as authorized contents. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's Safety Evaluation Report is also enclosed.

Those on the attached list have been registered as users of the package under the general license provisions of 10 CFR 71.17 or 49 CFR 173.471. This approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR 173.471. Registered users may request, by letter, to remove their names from the Registered Users List.

If you have any questions regarding this certificate, please contact me at (301) 492-3294 or Kim Hardin of my staff at (301) 492-3339.

Sincerely,

/RA/
Eric J. Benner, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9225
TAC No. L24181

Enclosures: 1. Certificate of Compliance
No. 9225, Rev. No. 49
2. Safety Evaluation Report
3. Registered Users List

cc w/encls. 1& 2: R. Boyle, Department of Transportation
J. Shuler, Department of Energy

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SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT Package
Certificate of Compliance No. 9225
Revision No. 49

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SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT Package
Certificate of Compliance No. 9225
Revision No. 49

SUMMARY

By application dated January 25, 2008, as supplemented July 17 and August 20, 2008, NAC International (NAC or the applicant) requested a revision to Certificate of Compliance (CoC) No. 9225 for the Model No. NAC-LWT packaging. NAC requested the incorporation of PWR mixed oxide (MOX) fuel rods as authorized contents.

The approval of the MOX contents are necessary to support the transport of pressurized water reactor (PWR) MOX and PWR UO_2 fuel rods to facilities for the completion of post-irradiation examinations (PIE) to evaluate the performance of these rods in commercial PWR reactors. It is the intent to complete the transport of the MOX fuel as soon as possible after discharge from the reactor.

For the new contents, NAC-LWT packagings will be transported with a leaktight containment boundary, including metallic containment seals on the closure lid and the alternate B port covers installed in the vent and drain ports, as recommended in NUREG-1617, Supplement 1, "Standard Review Plan for Transportation Packages for MOX Spent Nuclear Fuel."

Two license drawings were revised to incorporate the new MOX fuel rod transport cask arrangement requirements, including a provision for a leaktight containment boundary.

Accordingly, CoC No. 9225 has been amended based on the statements and representations in the application, and staff agrees that the changes do not affect the ability of the package to meet the requirements of Title 10 of the Code of Federal Regulations (10 CFR) Part 71

EVALUATION

The submittal was evaluated against the regulatory standards in 10 CFR Part 71, including the general standards for all packages, standards for fissile material packages, and performance standards under normal conditions of transport (NCT) and hypothetical accident conditions (HAC). Staff reviewed the application using the guidance in NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel," and NUREG-1617, Supplement 1, "Standard Review Plan for Transportation Packages for MOX Spent Nuclear Fuel."

Based on the statements and representations in the application, as supplemented, and the conditions listed in the CoC, the staff concludes that the design has been adequately described and evaluated and meets the requirements of 10 CFR Part 71.

REFERENCES

NAC International, application dated January 25, 2008.

NAC International, supplements dated July 17 and August 20, 2008.

1.0 GENERAL INFORMATION

1.1 Package Description

The Model No. NAC-LWT package is shipped by truck, within an ISO container, or by railcar, as a Type B(U)F-96 package, as defined in 10 CFR 71.4. There were no changes to the package in this application.

1.2 Packaging Drawings

The applicant submitted two revised license drawings. The revised drawings include:

LWT 315-40-01, Rev. 7	Legal Weight Truck Transport Cask Assembly
LWT 315-40-104, Rev. 3	Legal Weight Truck Transport Cask Assembly, PWR/BWR Rod Transport Canister

The drawings were revised to incorporate the new MOX fuel rod transport cask arrangement requirements, including a provision for a leaktight containment boundary.

1.3 Contents

The applicant modified the contents in this revision to add the following contents:

- Up to 16 undamaged PWR MOX, a mixture of plutonium and uranium oxides, fuel rods contained in a screened or free flow PWR/BWR Rod Transport Canister with a 5x5 rod insert as an approved content condition. The empty rod locations of the 5x5 insert may be loaded with inert burnable poison rods (BPRs).

- A mixed loading of up to undamaged 16 PWR MOX and UO_2 fuel rods. The empty rod locations of the 5x5 insert may be loaded with inert burnable poison rods (BPRs).

2.0 STRUCTURAL

The staff reviewed the application to revise the Model No. NAC-LWT package structural design and evaluation to assess whether the package will remain within the allowable values or criteria for normal conditions of transport (NCT) and hypothetical accident conditions (HAC) as required in 10 CFR Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 2 (Structural Review) of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

2.1 Structural Review Description

NAC has requested an approval for a revision to CoC No. 9225 to incorporate transporting up to 16 PWR MOX fuel rods, and a mixed loading of up to 16 PWR MOX and UO_2 fuel rods.

The existing safety analysis report (SAR), and NAC License Drawings were revised to reflect inclusion of these additional contents and submitted for the NRC staff review.

2.2 Material Properties

This revision request includes the addition of up to 16 undamaged MOX fuel rods as an approved content for the NAC-LWT cask. The rods have zirconium alloy cladding. The materials used in the construction of the NAC-LWT transport system have been previously approved so this amendment review will only be concerned with the behavior of the MOX fuel and the interaction of the fuel with its environs.

Since the cladding is intact there are no interactions of the UO_2 - 7%PuO_2 MOX fuel meat with the environment. There are no potential interactions of the intact cladding with the inert, dried environment other than some micron level oxidation due to the tramp impurities in the cover gas or residual water.

Gross cladding breach during transport could cause relocation of the fuel, and fission gas released (fgr) from the fuel could cause overpressure of the cask cavity, thereby providing a source term for release in case of an accident. Breach would occur if the rod overheated or the internal hoop stress on the cladding was excessive. The stress on the cladding results from three components: 1) the initial fill gas, 2) the fgr from the fuel to the plenum, and 3) helium generated. The staff is aware of data indicating that the fgr from MOX fuel is the same as from LWR fuel. This would be expected since the MOX is mostly UO_2. Therefore the 30% gas release used in the analysis should be bounding. The initial fill gas is similar for MOX and normal LWR fuel rods, and He generation is a long term, not short term effect. The stress expected in the MOX fuel rods is similar to that expected in LWR fuel rods. The peak cladding temperature was found to be less that 400°C; therefore, per ISG-11, Rev. 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel," no gross breach during normal transport is expected.

The staff has no materials issues with adding the requested MOX fuel as an approved content to the CoC.

2.3 Structural Evaluation

The transport canister will be inserted into the PWR basket insert loaded into the PWR basket. The transport configuration will be identical to the currently licensed shipping configuration for LWR rods except cask containment is in the leak tight configuration (i.e. all metal seals).

Chapter 2 of the existing SAR was verified by the staff to ensure that the newly revised MOX and PWR payload is enveloped by the current content (25 PWR or BWR rods) maximum weight. The total weight of MOX rods including the fuel rod inserts, transport canister and PWR basket spacer is less than 1,300 lbs. The current structural evaluations are performed using a bounding load of 1,500 lbs. Also, the proposed MOX fuel rod payload meets the geometry requirements such as length, diameter, etc., of previous LWR rod evaluations. In summary, no change to the current SAR structural evaluation was performed by the applicant.

2.4 Conclusions

Based on the above discussion, the staff concurs with the applicant's request as there is no new situation that might affect the structural integrity of the payload during the shipment. There is a reasonable assurance that the package will meet the structural adequacy requirements of 10 CFR Part 71.

3.0 THERMAL

The staff reviewed the application to revise the Model No. NAC-LWT package thermal design and evaluation to assess whether the package temperatures will remain within their allowable values or criteria for NCT and HAC as required in 10 CFR Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 3 (Thermal Review) of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

3.1 Thermal Review Description

The purpose of this amendment is to allow transport of PWR MOX and PWR UO_2 fuel rods to facilities for PIE to evaluate the performance of the MOX fuel rods in commercial PWR reactors. This amendment requests transport of up to 16 PWR MOX fuel rods contained in a screened or free flow PWR/BWR Rod Transport Canister with a 5 x 5 rod insert within the NAC-LWT transportation package. Also requested, is for the content to include a mixed loading of up to 16 PWR MOX and UO_2 fuel rods. For both of the aforementioned contents, the remaining nine empty locations within the 5x5 insert 'may' be loaded with inert BPRs. The PWR MOX will be transported in a leaktight containment boundary which includes metallic containment seals on the closure lid and the Alternate B port covers for the vent and drain ports. Helium is backfilled into the cask cavity at atmospheric pressure subsequent to vacuum drying.

3.2 Thermal Evaluation

The maximum decay heat for the 16 PWR MOX rods (or combination of PWR MOX and standard PWR fuel rods) is 2.3 kW (143 watts/rod) with a peaking factor of 1.1 or 2.53 kW. The remaining nine slots in the 5X5 insert may be loaded with BPRs or other intact components with a total additional heat load of less than 10 watts. The 2-D planar analysis that was previously performed used a 5X5 BWR configuration for high burnup BWR rods with a maximum heat load of 2.1 kW with a peaking factor of 1.22 for a total heat load of 2.56 kW (i.e., 2.1 x 1.22). Since the previous analysis documented in Section 3.4.1.7 uses a higher heat load (i.e., 2.56 kW) for the 25 rod high burnup BWR fuel configuration, it bounds the heat load for the high burnup MOX fuel (i.e., 2.53 kW).

Table 3.4-10 of the SAR states the NCT maximum component temperatures for two conditions. The first condition is for transport of the NAC-LWT in an ISO container with helium in the LWT cask, and the second condition is for transport via trailer with air in the LWT cask. The second condition was performed to determine the temperatures for a postulated leakage of all the helium gas out of the cask. However, this condition is unrealistic and is beyond the design basis of the cask since all shipments are made with helium as the gas within the cask. Both Sections 3.4.1.7.3 and 3.4.1.15 for high burnup PWR or BWR rods in a rod holder and high burnup PWR MOX rods, respectively, reference Table 3.4-10 as the demonstration that all component temperatures are maintained within their allowable limits. The applicant has revised Table 3.4-10 to include the seal regions of the cask as well as allowable temperature limits for all components with helium as the cavity gas.

For HAC, as a result of staff comments, the applicant has revised Section 3.5.3.13, "Evaluation of 16 PWR MOX High Burnup Rods," to describe the basis for meeting component temperature limits. Also, the results presented in Figure 3.5-4 (O-Rings), Figure 3.5-5 (lead gamma shield), and Tables 3.5-4 and 3.5-5 (cladding) demonstrate that the LWT components meet their allowable temperatures.

The three important to safety components that were demonstrated to be maintained within their safe operating range for NCT and HAC are the O-ring seals, the lead gamma shield, and the neutron shield (composed of a mixture 56% ethylene glycol and water-for NCT only since it is assumed to fail for HAC). Additionally, other vital component temperature limits were identified (e.g., fuel cladding, shell, basket, etc.) and compared favorably to their estimated temperatures for both the NCT and HAC.

For the maximum pressure evaluation, the applicant performed a parametric study to demonstrate that the 50 psig used in the NCT structural analysis was still bounding for rod failures of 75 % and 100%, as documented in Section 3.4.4.7 of the SAR. For the maximum pressure evaluation for HAC, the applicant estimated, in Section 3.5.4.6 of the SAR, a maximum HCT pressure of approximately 65 psig for 100% rod failure and 100% fission gas release. This analysis compares favorably to a maximum HAC pressure of 125 psig used in the structural analysis.

As requested in their August 20, 2008, response to staff's questions, the applicant removed the reference to the heat load as being per rod.

Additional information was provided by the applicant which adequately addressed the staff's concerns regarding the identification of all important components and specifying their maximum calculated temperature, as well as their associated temperature limit.

3.3 Conclusion

Based on the review of the application, the staff found reasonable assurance that the applicant has demonstrated that the NAC-LWT package for transport of 16 PWR MOX fuel rods or a combination of 16 PWR MOX fuel rods and UO_2 fuel rods, both with up to 9 BPRs meets the thermal requirements for NCT and HAC as required by 10 CFR Part 71.

4.0 CONTAINMENT

The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the package containment design has been described and evaluated under NCT and HAC as required in 10 CFR Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 4 (Containment Review) of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

4.1 Containment System Design

The 16 PWR MOX fuel rods, with or without UO_2 fuel rods, with or without nine BPRs, will be transported in a leaktight containment boundary, which includes metallic containment seals on the closure lid and the Alternate B port covers for the vent and drain ports.

4.2 Containment Evaluation

Since a leaktight containment boundary to 1 X $10E^{-7}$ ref. cc/sec (per ANSI 14.5-1997) is required, no radiological evaluation of postulated release of the source term is required. The staff verified that Section 7.1.12 “Procedure for Wet Loading PWR MOX Fuel Rods in a Transport Canister Into the NAC-LWT Cask” of the SAR included leaktight testing as documented in Steps 32 and 33, for the closure lid and Alternate B vent and drain port covers.

4.3 Conclusion

Based on the statements and representations in the application, staff agrees that the applicant has shown that the use of the NAC-LWT for transport of 16 PWR MOX fuel rods or a combination of 16 PWR MOX fuel rods and UO_2 fuel rods, both with up to 9 BPRs, meet the requirements of 10 CFR Part 71 for the containment.

5.0 SHIELDING

The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the shielding design has been described and evaluated under NCT and HAC, as required in 10 CFR Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 5 (Shielding Review) of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

5.1 Shielding Design

The package uses a PWR fuel rod insert to hold the fuel rods. The fuel rod insert is placed in a screened or free flow PWR/BWR Rod Transport Canister. The fuel rod insert is a square lattice of 5x5 cells. Up to nine depleted burnable poison rods may be loaded in addition to the 16 fuel rods. License drawings 315-40-01 and 315-40-104 provide information on the structural configurations and dimensions of the PWR MOX fuel rod transportation package. The maximum burnup is 62.5 GWd/MTHM. The minimum cooling time is 90 days for non-power-grade PWR MOX fuel and 120 days for power-grade PWR MOX fuel. The surface dose rate is 110 mrem/hr under NCT and 370 mrem/hr at 1 meter from the package surface under HAC.

The SAS2H module of the SCALE 5.0 computer code system is employed in the fuel assembly depletion/source term analyses. MCNP5 is employed in both the shielding and criticality analyses. The Transport Index is 28 for both the PWR MOX fuel package and mixed PWR MOX and UO_2 fuel rod package.

5.2 Shielding Evaluation

Chapter 5 of the revised SAR provides shielding safety evaluations for the PWR MOX fuel rods or mixed PWR MOX and UO_2 fuel rod package. The NAC LWT packaging utilizes a lead layer for gamma radiation shielding and borated water/ethylene glycol layer outside the container body for neutron shielding. Engineering drawings 315-40-01 and 315-40-104 provides the design of the NAC-LWT PWR MOX fuel transportation package.

The applicant calculated the neutron and gamma source terms of the PWR MOX fuel rods with 7 wt% Pu-239 content, 70 GWd/MTHM burnup, and a minimal cool time of 90 days using the SAS2H module of the SCALE-5.0 code system. Table 5.1.1-2 of the SAR provides parameters of the design basis PWR MOX fuel. Table 5.1.1-3 of the SAR provides the total gamma and neutron source terms of the design basis PWR MOX fuel rod package.

Considering the fact that the SAS2H module is neither benchmarked nor validated for MOX fuel with burnup greater than 20 GWd/MTHM, the applicant used the source term calculated with a 70 GWd/MTHM burnup. This can be considered as an additional safety margin for the shielding evaluation because 70 GWd/MTHM will produce a source term approximately about 10% more than the actual source term produced by fuel with 62.5 GWd/MTU as requested. This additional margin provides reasonable assurance that the uncertainties introduced in the SAS2H source term calculations for high burnup fuel are bounded.

The applicant calculated the gamma and neutron source terms for the design basis fuel. Since the SAS2H is a one dimensional code, the applicant used the following source term and assembly burnup relationship published in Oak Ridge National Laboratory's (ORNL's) report ORNL/M-5503, "The Radioactive Materials Packaging Handbook," to relate the average burnup to the axial source term distribution.

$$S = aB^b ,$$

where ***B*** is the fuel assembly burnup and ***a*** and ***b*** are constants obtained via regression analyses of the fuel radiation source term as a function of burnup. The typical value of b is 1.0 for the gamma source terms and 4.22 for the neutron source terms based on ORNL's report. To increase the flexibility, the applicant introduced a scaling factor, ***r,*** to eliminate the dependence of the absolute value of the assembly specific source term, ***a,*** in the equation.

$$r = \frac{\overline{S}}{S(\overline{B})} = \frac{\int B^b dz}{a\overline{B^b}}$$

When the burnup profile is normalized to unity, the above equation reduces to

$$r = \frac{1}{H}\int B^b dz .$$

Where H is the assembly height and B is the assembly burnup along the axial direction.

The staff requested that the applicant provide its justification for the applicability of these values to the MOX fuel because these values were derived from regression analyses of a large set of UO_2 fuel assemblies, and therefore, may not be applicable to the MOX fuel. The applicant provided, in its response to the RAI, actual data to demonstrate that these values are conservative. The applicant also updated the SAR to include the actual data as the basis for using these two values in the dose rate calculations. The staff reviewed the applicant's response to the staff's questions and the updated SAR and determined that the applicant provided reasonable assurance that using these values will produce conservative shielding results.

The applicant calculated the dose rates at the surface, 1 meter from the surface, 2 meters from the surface, and 4 meters from the surface of the cask using MCNP5, a three dimensional transport theory-based Monte Carlo code. The applicant simplified the source term distribution in the model by omitting the fuel rod lattice details in the fuel rod insert. As such, all 16 rods are assumed to be loaded in a tight configuration in the 5x5 PWR fuel rod insert. No credit is taken for the stainless steel insert structural material. Figure 5.3.18-5 of the SAR provides a sample input file of the MCNP shielding model.

The applicant used a dose rate response function method to simplify the calculations of the dose rates at different points of interest around the cask or the legal weight truck. During the review, the staff requested that the applicant provide additional information on the validity of the response function method. The applicant provided additional explanation on the method in its response to the RAI and the revised SAR. Based on its review, the staff found the results acceptable because the data showed that the response function method produced results similar to that of the MCNP calculations for this design.

It should be noted that the staff does not agree with the applicant's assertion that, "Further response functions were generated as part of the RAI response set to provide documentation that fuel material isotopic composition (i.e., MOX or UO_2) is irrelevant to the safety conclusion of the shielding evaluations performed in Section 5.3.18." The staff considers this statement incorrect because the transport of particles depends highly on the nuclear property of the media they transverse. Since the response function completely decouples the material dependency in its dose rate calculation, the accuracy of the results, in general, is not guaranteed, even though it may produce results that are in agreement with more rigorous methods such as S_N or Monte Carlo (as displayed in this case). The validity of this type of approach will be assessed on a case-by-case basis. However, based on the staff's confirmatory analyses, the staff found that there was sufficient margin to provide reasonable assurance that the design meets 10 CFR Part 71.

The neutron source from subcritical multiplication is included in the dose rate calculations. A 4 wt% enriched UO_2 system was used in calculations of the subcritical multiplication of the package. This initial enrichment was selected because it bounds all contents in relevance to radiation safety analyses because low enrichment fuels produce a higher source term when the burnup is high.

The applicant also described the NAC-LWT MOX fuel package under HAC. The applicant assumed that in an HAC event, the package would lose neutron shield together with its shell, and gap would develop on the gamma shield due to lead slump. The impact limiters were also assumed to be lost during an accident.

Based on these assumptions, the applicant evaluated the dose rates from the NAC-LWT MOX fuel package for transportation. The table below summarizes the dose rates of the MOX fuel package under NCT and HAC.

Condition	Dose Rate Location	Max Dose Rate (mrem/hr)
NCT	Side Surface of Cask	1.1E+02
	Top Surface of Cask	8.6E-01
	Bottom Surface of Cask	1.2E+01
	Side 1 m (Transport Index)	2.8E+01
	2m from Truck – Radial	9.2E+00
	2m from Top	3.3E-01
	2m from Bottom	7.6E-01
	Edge of Truck – Top	6.6E-02
	Edge of Truck – Bottom	6.2E-01
	Dose at Cab of Truck	2.3E-02
HAC	Side Surface of Cask	4.1E+03
	Top Surface of Cask	6.6E+00
	Bottom Surface of Cask	6.5E+01
	Side 1 meter	3.7E+02
	Top 1 meter	1.3E+01
	Bottom 1 meter	7.4E+01

The maximum dose rate is 110 mrem/hr on the radial surface and 9.2 mrem/hr at 2 meters from the surface of the truck under NCT. The maximum dose rate is 370 mrem/hr at 1 meter from the cask surface under HAC. The Transport Index (TI) is 28.

The staff evaluated the applicant's calculations on the gamma and neutron source terms for the NAC-LWT 16 PWR MOX fuel rod package. The staff performed independent depletion analyses for the new payload using the transport theory-based three dimensional nuclear fuel depletion code TRITON of the SCALE-5.1 system. The results show good agreement with the source terms calculated by the applicant, as presented in the SAR.

5.2 Conclusion

The staff performed confirmatory shielding analyses for the NAC-LWT 16 PWR MOX or mixed PWR UO_2 and MOX fuel rod package. Based on its review and analyses, the staff found that the dose rates of the package meet all the requirements of 10 CFR 71.47, and that the package meets the shielding requirements of 10 CFR Part 71.

6.0 CRITICALITY

The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the criticality design has been described and evaluated under NCT and HAC, as required in 10 CFR Part 71. This application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 6 (Criticality Review) of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

6.1 Criticality Design

The request for amendment to the Certificate of Compliance seeks approval to transport up to 16 PWR MOX or mixed MOX and UO_2 fuel rods in a 5x5 lattice rod holder insert placed inside a screened or free flow PWR/BWR Rod Transport Canister. The request seeks approval to load up to nine burnable poison rods in the vacant cells of the 5x5 insert. The PWR MOX fuel rods or mixed PWR MOX and UO_2 fuel rod package contains a maximum fuel mass of 42.08 kg of heavy metal, 2.63 kg heavy metal (uranium + plutonium) per fuel rod. The maximum enrichment is 5 wt% U-235 for the UO_2 fuel and 7.0 wt% Pu-239 of heavy metal for PWR MOX fuel.

The CSI value is 0.0 for the PWR MOX fuel rod packaging, the mixed PWR MOX and UO_2 fuel rods, or the combination of one of these two packages with depleted burnable poison rods.

6.2 Criticality Evaluation

Chapter 6 of the revised SAR provides the criticality safety analyses for the PWR MOX fuel package. The 16 PWR MOX fuel rods or mixed PWR UO_2 and MOX rods package uses a 5x5 tube array of PWR rod insert canisters as the fuel rod holder. All fuel rods are intact; no damaged fuel rods are permitted.

The maximum uranium enrichment is 5 wt% U-235 for the PWR UO_2 fuel rods and 7 wt% fissile plutonium for the PWR MOX fuel rods. Figure 6.7.1-1 of the SAR provides the dimensions of the 16 PWR MOX fuel rods or mixed PWR UO_2 and MOX fuel rods. Tables 6.7.1-1 and 6.7.1-2 provide data on the characteristics of the PWR MOX fuel rods.

The applicant performed the criticality safety analyses for the PWR MOX fuel rods and PWR UO_2 rod package. The applicant's evaluation of the packages includes considerations of preferential flooding, moderator density variations, geometric tolerance variations, and HAC. All fuels are assumed to be fresh; no burnup credit is taken.

The MCNP5 particle transport analysis computer code with ENDF/B-VI cross section data set was used in the package criticality safety evaluation. The MCNP5 code was verified against a set of critical experiments selected from the International Handbook of Evaluated Criticality Safety Benchmark Experiments. The applicant also evaluated the area of applicability of the code and the Upper Safety Limit (USL) of the model. The discussions of the criticality evaluations for the package are presented in Section 6.7 of the SAR. Table 6.7.1-3 shows the applicant's evaluation results of reactivity change as a function of rod pitch and fissile material types. The maximum reactivity is 0.73378 (k_{eff} $\pm 2\sigma$). Table 6.7.1-4 shows a comparison of reactivity with different rod lattice configurations, i.e., square and hexagonal. The maximum reactivity is 0.73463 (k_{eff}

$\pm 2\sigma$) for a pure P_u-241 system with a square lattice and 3.6 cm rod pitch. Table 6.7.1-5 shows maximum reactivity with optimum moderator density with different fissile material systems.

On page 6.7.1-11 of the SAR, the applicant states, "Evaluations of a mixed shipment of enriched UO_2 rods and MOX rods are not required, as the reactivity of the evaluated MOX rods are significantly higher than those of the UO_2 rods. Mixed shipments are, therefore, permitted." The reactivity of the mixed MOX and UO_2 package is not a simple addition or average of the two parts. It involves the coupling of the two different fission systems. However, considering the system's low reactivity, the staff determined that the applicant provided reasonable assurance for criticality safety for this package design, and hence meets the requirements of 10 CFR Part 71. It should be noted that explicit calculations are expected for future package designs with less margin on k_{eff}.

The applicant also performed criticality safety analyses for arrays of the package with bounding payload pursuant to 10 CFR 71.73. The CSI has been calculated for the most reactive loading pattern. The bounding k_{eff} for an infinite array of the PWR MOX fuel package is 0.81386 ($k_{eff} \pm 2\sigma$). The CSI is 0 because an infinite array of the package under normal conditions of transport and hypothetical accident conditions remains subcritical.

6.3 Conclusion

The staff reviewed the amendment requests and evaluated the information provided. The staff also performed independent analyses for the bounding package loading configuration using SCALE 5.1. Based on the review of the application and results of the analyses, the staff found that the Model No. NAC-LWT packaging with a payload of up to 16 PWR MOX or mixed UO_2 and MOX fuel rods meets the criticality safety requirements of 10 CFR Part 71.

7.0 PACKAGE OPERATIONS

The staff reviewed Chapter 7 of the SAR in the application to revise the Model No. NAC-LWT package to verify that it meets the requirements of 10 CFR Part 71 and is adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

The chapter includes the procedures for package loading, unloading, and preparation of the empty package for transport. To support this revision request, Section 7.1.12 of the SAR was revised to include the procedures for loading the PWR MOX fuel rods and mixed PWR UO_2 and MOX fuel rods packages. Section 7.2.1 of Chapter 7 provides operating procedures for unloading the PWR MOX fuel rods and mixed PWR UO_2 and MOX fuel rods packages.

The staff reviewed and evaluated the proposed loading procedures for loading and unloading the PWR MOX fuel rods and mixed PWR UO_2 and MOX fuel rods packages.

Based on the statements and representations in the application, the staff concludes that the package operations meet the requirements of 10 CFR Part 71 and that they are adequate to assure the package will be operated in a manner consistent with its evaluation for approval. Further, the CoC is conditioned to specify that the package must be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7 of the application.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The staff reviewed the revisions to Chapter 8 of the application to verify that the revised acceptance tests for the packaging meet the requirements of 10 CFR Part 71.

To support this revision request, Sections 8.1.3.1, 8.1.3.2.1, 8.1.3.3.1, 8.1.3.3.2, and 8.2 of the SAR were revised to describe the requirements for acceptance testing and maintenance of the leaktight containment boundary.

Based on the statements and representations in the application, the staff concludes that the revised acceptance tests for the packaging meet the requirements of 10 CFR Part 71. Further, the CoC is conditioned to specify that each package must meet the Acceptance Tests and Maintenance Program of Chapter 8 of the application.

CONDITIONS

The CoC has been revised as follows:

Condition Nos. 5(a)(3)(i) and 5(a)(3)(ii):

Two drawings were revised.

Condition No. 5(b)(1)(xvii):

Details on the type and form of material were added for the additional contents of the PWR MOX (mixed oxide) fuel.

Condition No. 5(b)(2)(xviii):

Provides for the maximum quantity of material per package for the additional contents of the PWR MOX (mixed oxide) fuel.

Condition No. 5(c):

PWR MOX rods were added to the contents with a criticality safety index of 0.0.

Condition No. 6:

A typo was corrected.

Condition No. 8:

The word “alternate” was added before “vent and drain port covers” for clarity.

Condition No. 10:

The words “O-ring seal” was clarified as “O-ring lid seal.”

Condition No. 11:

The PWR MOX fuel was added to the requirements for the neutron shield tank.

Condition No. 12:

The PWR MOX fuel was added to the requirements for a personnel barrier.

Condition No. 17:

Condition added to state the requirements for the free flow or screened PWR/BWR fuel rod canister.

Condition No. 20:

Allows the use of Revision 48 of this certificate for one year.

CONCLUSION

Based on the statements and representations in the application, as supplemented, and the conditions listed above, the staff concludes that the Model No. NAC-LWT package design has been adequately described and evaluated and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9225, Revision No. 49,
on October 10, 2008.