May 29, 2008

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

SUBJECT: REVISION 47 OF CERTIFICATE OF COMPLIANCE NO. 9225 FOR THE MODEL NO. NAC-LWT PACKAGE

Dear Mr. Patko:

By letter dated January 17, 2008, as supplemented February 27, April 8, and April 11, 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 modify the TRIGA fuel authorization. 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 or Kim Hardin of my staff at (301) 492-3338.

Sincerely,

/RA/
Meraj Rahimi, Acting Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9225
TAC No. L24175

Enclosures: 1. Certificate of Compliance
No. 9225, Rev. No. 47
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. 47

SUMMARY

By letter dated January 17, 2008, as supplemented February 27, April 8, and April 11, 2008, NAC International (NAC or the applicant) submitted a revised application in accordance with 10 CFR Part 71 for an amendment to Certificate of Compliance (CoC) No. 9225 for the Model No. NAC-LWT package to revise the TRIGA fuel description to incorporate low enriched uranium (LEU) cluster rods (intact or damaged) as authorized contents. To support this request, NAC provided changes to the Safety Analysis Report (SAR), Chapter 7, "Operating Procedures," and various drawings.

EVALUATION

The submittal was evaluated against the regulatory standards in 10 CFR Part 71, including the general standards for all 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."

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 17, 2008.

NAC International, supplements dated February 27, April 8, and April 11, 2008.

1.0 GENERAL INFORMATION

1.1 Package Description

NAC requested that the NAC-LWT package be authorized for the transport of LEU intact or damaged cluster rods (contents change only). High enriched uranium (HEU) cluster rods are currently authorized contents for this package. Chapter 7, "Package Operations," and some drawings were updated to incorporate the above changes and provide some clarifications.

Minor editorial changes were made throughout the SAR without changing the technical content.

1.2 Packaging Drawings

Four updated license drawings were included in this submittal:

Drawing LWT 315-40-02, Rev. 22 (Sheets 1-2)	Body Assembly
Drawing LWT 315-40-079, Rev. 5	Transport Cask Assembly, 120 TRIGA Fuel Elements or 480 Cluster Rods
Drawing LWT 315-40-084, Rev. 4	LWT Transport Cask Assy, 140 TRIGA Elements
Drawing LWT 315-40-096, Rev. 3	Fuel Cluster Rod Insert, TRIGA Fuel

License drawing 315-40-85, Rev. 0, was modified to correct the title. License Drawing LWT 315-40-03, Rev. 22 (Sheets 1-7) was corrected to have 7 sheets rather than 6. The revised drawings were updated to clarify changes for the addition of TRIGA low enriched uranium (LEU) cluster rods and associated sealed damaged fuel cans (DFCs) and leaktight containment boundary.

1.3 Contents

Two basic types of TRIGA fuel are authorized for transport in the NAC-LWT cask: TRIGA fuel elements and smaller fuel rods from TRIGA fuel cluster assemblies.

This request is to add LEU TRIGA fuel cluster rods (intact or damaged) as authorized contents. The TRIGA fuel elements and cluster rod contents are divided into three categories: intact fuel, damaged TRIGA elements and cluster rods, and TRIGA fuel elements and cluster rod debris.

TRIGA fuel elements and high enriched uranium (HEU) cluster rods using the NAC-LWT package have been previously approved as authorized contents for the Model No. NAC-LWT package. Any damaged fuel elements, cluster rods, or debris shall be loaded and transported in a sealed DFC in a leaktight configuration. The hydrogen to zirconium (H/Zr) ratio is requested to be 1.7 for both the HEU and LEU cluster rods.

2.0 STRUCTURAL AND MATERIALS

The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the package structural 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 2 (Structural Review) of NUREG-1617, “Standard Review Plan for Transportation Packages for Spent Nuclear Fuel.”

2.1 Materials Review

The Model No. NAC-LWT package structural design and analysis were not modified nor were any changes requested.

Damaged and undamaged TRIGA fuel had been previously approved as acceptable contents with respect to any material issues with the cask materials, welds, etc. Staff reviewed the possible interaction of the TRIGA cluster rods with the container. In particular, the following aspects were reviewed:

1) the definition of damaged TRIGA fuel as TRIGA fuel (elements and cluster rods) with cladding breaches greater than pinholes or hairline cracks, and

2) the use of the source terms previously developed for LWR fuel utilized for TRIGA fuel.

Intrusion of water into the fuel with breaches of any size in the cladding can cause corrosion of the fuel meat and the cladding, resulting in a brittle cladding susceptible to fracture in an accident, and a fuel meat potentially reduced to a powder. The SAR and CoC was revised to define damaged TRIGA fuel as any TRIGA elements or cluster rods that have a cladding breach that allows the escape of gas or intrusion of water. Staff agrees that this definition will provide reasonable assurance that the requirements of 10 CFR Part 71 will be met.

The staff agrees that no materials issues exist with the inclusion of the intact and damaged TRIGA cluster rods and elements as approved contents in the quantity stated in the CoC and the definition stated in the CoC.

2.2 Conclusion

Based on the review of the application, the staff found reasonable assurance that the applicant has demonstrated that the revision request is bounded by previously approved contents under NCT and HAC. The staff agrees that the changes do not affect the ability of the package to meet the structural integrity and material requirements of 10 CFR Part 71.

3.0 THERMAL

The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the package thermal 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 3 (Thermal Review) of NUREG-1617, “Standard Review Plan for Transportation Packages for Spent Nuclear Fuel.”

The staff reviewed the application and determined that the thermal analyses (heat load and maximum normal operating pressure) of this application were not changed and were bounded by the previously approved contents.

Based on the review of the application, the staff found reasonable assurance that the applicant has demonstrated that the revision request is bounded by previously approved contents under NCT and HAC. The staff agrees that the changes do not affect the ability of the package to meet the thermal requirements of 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" and NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

4.1 Containment Review

Staff guidance presents a releasable fines estimate for a cladding breach from PWR and BWR spent fuel. This estimate may not be applicable for damaged TRIGA fuel with multiple cladding defects or for fuel debris. The applicant supplemented their revision request to clarify that damaged TRIGA LEU cluster rods would be loaded into a sealed DFC and then the DFC would be loaded into a leaktight configuration of the NAC-LWT cask for transportation. This leaktight configuration is the same as was already approved for TBBAR contents.

For intact TRIGA fuel, the applicant has demonstrated (refer to Table 4.2-4 of the application) that the current helium leak rate test of 5.5E-7 cc/s is bounding for the various intact TRIGA fuels and associated release fraction assumptions.

To accommodate transportation of the TRIGA damaged fuel or debris, Chapter 7, "Package Operations" and Chapter 8, "Acceptance Tests and Maintenance Program," were modified to indicate loading into DFCs and leak testing to the leaktight criteria of ANSI/ANS 14.5-1997. Also, to ship to the leaktight criteria, the Alternate B vent and drain port covers will be utilized with new metallic O-ring gaskets. Drawing 315-40-084, Rev. 4, "Legal Weight Truck Transport Cask Assembly, 140 TRIGA Elements," was changed to note that TRIGA damaged fuel or fuel debris will be sealed in DFCs and the transportation cask will be provided with a leaktight containment boundary.

4.2 Conclusion

Based on the review of the application, the staff found reasonable assurance that the applicant has shown that the revision request does not affect the ability of the package to meet the containment requirements of 10 CFR Part 71.

5.0 SHIELDING

The applicant provided a shielding evaluation for the package containing the requested content changes in Chapter 5 of the application. The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the package 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 Review

The LEU TRIGA cluster rods are shipped in a 4x4 rod structure. The package uses basket cells to hold the fuel cluster rods. Each cell holds one group of rods. The fuel cells are then loaded into fuel baskets. Only six out of the seven fuel cells are permitted to be loaded per fuel basket, with the center cell vacant but welded shut, for the non-poisoned cask design to be used for the TRIGA cluster rods or damaged TRIGA fuel elements. The NAC-LWT package with non-poisoned baskets can hold up to 480 intact

TRIGA cluster rods. License drawing 315-40-79 shows the loading configuration of the TRIGA cluster rods.

The damaged fuel elements and fuel debris will be loaded into sealed DFCs. Each DFC can hold up to the equivalent of six cluster rods. The DFCs must be loaded into a top or base basket at either end or both ends of the NAC-LWT package inner payload canister.

The maximum enrichment is 20 wt% U-235 with an H/Zr ratio of 1.7. The maximum burnup is 140 GWd/MTU. The minimum cooling time for the TRIGA fuel is 90 days.

Chapter 5 of the revised SAR provides shielding evaluations for the neutron and gamma dose rates for the TRIGA LEU rod cluster spent fuel payload. The LEU TRIGA fuel rods contain a maximum design-basis fuel mass of 288.4 grams of U (19 wt% U-235) for the LEU elements. All H/Zr ratios for the TRIGA fuel cluster rods are requested to be 1.7. This request only affects the criticality calculations; therefore, the shielding analyses were not redone.

The NAC-LWT packaging utilizes a lead layer for gamma shielding and borated water/ethylene glycol layer outside the container body for neutron shielding. The applicant calculated the neutron and gamma source terms of the spent TRIGA cluster rods with 19 wt% U-235, 140 GWd/MTU burnup and a minimal cool time of 90 days using SAS2H module of the SCALE code system. Table 5.1.1-3 provides data for the TRIGA LEU cluster rods. The gamma source term is provided in Table 5.3.7-5 and the neutron source term is provided in Table 5.3.7-6.

The staff evaluated the applicant's calculations of the gamma and neutron source terms for the LEU TRIGA cluster rod spent nuclear fuel. The staff performed independent depletion analyses for the new payload using the transport theory-based 3-D 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.

The max dose rate is approximately 40 mrem/hr on the surface and 5.2 mrem/hr at 2 meters from the surface of the package under normal condition of transport. The dose rate is 34.6 mrem/hr under hypothetical accident conditions. The Transport Index (TI) is 17.9.

The staff performed confirmatory shielding analyses for the LEU TRIGA cluster rods spent nuclear fuel transportation packages. The results indicate that dose rates meet the requirements pursuant to 10 CFR 71.47. The previously approved package with HEU TRIGA cluster rods up to 93.3 wt% U-235 was also evaluated under the H/Zr ratio of 1.7. The maximum burnup is 140 GWd/MTU. There is no significant difference in the source term and shielding safety under the same conditions as previously evaluated.

The staff evaluated the shielding safety analysis for the packages that are loaded with intact or damaged LEU TRIGA rod cluster spent fuel. The staff found that the applicant has correctly modeled and analyzed the shielding safety of these packages. The dose rates meet all the requirements of 10 CFR 71.47.

5.2 Conclusion

Based upon the information provided by the applicant, the staff has reasonable assurance that the applicant's shielding analyses demonstrate that the package design meets radiation standards in 10 CFR Part 71.

6.0 CRITICALITY

The applicant provided a criticality evaluation for the package containing the requested content changes in Chapter 6 of the application. The staff reviewed the application to revise the Model No. NAC-LWT package to verify that the package criticality safety 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 Safety Review

Chapter 6 of the application provides criticality safety analyses for the LEU TRIGA cluster rods spent fuel package. The fuel consists of UZrH. The maximum uranium enrichment is 20 wt% for the LEU TRIGA cluster rod spent fuel. The maximum H/Zr ratio is 1.7. Figure 6.2.6-1 of the application provides the dimensions of the LEU TRIGA cluster rods. Tables 6.2.6-1 and 6.2.6-2 of the application present data on the characteristics of the TRIGA cluster rods.

The TRIGA fuel package contains 5 basket modules aligned axially top to bottom. There is one top module and 3 intermediate modules. Each basket module contains 7 cells which are filled with the TRIGA fuel. The LEU TRIGA cluster rods are shipped using both poisoned and non-poisoned TRIGA baskets.

The maximum load for the LEU TRIGA cluster rods in the non-poisoned baskets is 480 rods with 16 rods per fuel cell, 6 cells per basket, and 5 baskets per package loaded along the axial direction in the package inner cask cavity. The center cells of the fuel baskets must not be loaded and is welded shut. The applicant modeled the fuel as unirradiated for the criticality safety analysis.

The maximum load for the LEU TRIGA fuel rods in the poisoned baskets is 560 rods with 16 rods per fuel cell, 7 cells per basket, and 5 baskets per package loaded along the axial direction in the package inner cask cavity. Fuel may be loaded in the center cell of the poisoned fuel basket. The applicant modeled the fuel as unirradiated for the criticality safety analysis.

Damaged TRIGA fuel cluster rods or debris (up to six equivalent rods) may be transported in a sealed DFC. Intact and damaged fuel may be mixed in the same package. Base and top fuel basket modules may contain intact or damaged fuel elements or cluster rods or sealed DFCs. Intermediate fuel rods may contain only intact TRIGA fuel elements or cluster rods.

Figures 6.3.5-1, 6.3.5-2, 6.3.5-3, 6.3.5-4, 6.3.5-5, and 6.3.5-6 illustrate the different TRIGA cluster rods criticality models of the NAC-LWT package.

The applicant evaluated the criticality safety of the package with considerations of preferential flooding, moderator density variations, geometric tolerance variations, and accident conditions. The discussions of the criticality evaluations for the LEU TRIGA cluster rods are presented in Section 6.4.6. Tables 6.4.6-2, 6.4.6-4, and 6.4.6-5 show the results of these evaluations. The most reactive configuration is the preferentially-flooded package loaded with sealed DFCs. The k_{eff} for this package is 0.8713 (including 2σ).

The applicant also performed criticality safety analyses for arrays of the packages with bounding payload pursuant to 10 CFR 71.59. The Criticality Safety Index (CSI) has been calculated for the most reactive loading pattern. The bounding k_{eff} for the infinite array of the packages is 0.86770. The CSI is 0 because an infinite array of the packages under NCT and HAC remains subcritical.

The staff reviewed the revision request and evaluated the information provided. The staff also performed a confirmatory analysis for the bounding package loading configuration. Additionally, the staff also evaluated the criticality safety for the previously approved HEU (up to 93.3 wt% U-235) with new H/Zr ratio of 1.7. The k_{eff} value is 0.9088 ± 0.0012.

Based on the review and confirmatory analysis results, the staff found that the applicant has demonstrated that the Model No. NAC-LWT package with the payload of LEU TRIGA cluster rods meets the criticality safety requirements of 10 CFR Part 71 provided that the cell (cell number 1) in the center of each basket is not loaded with fuel, except when loaded into a non-poisoned basket. The procedures require that the center cell be welded shut prior to any loading.

6.2 Conclusion

The applicant has shown and the staff agrees that the Model No. NAC-LWT package containing the LEU TRIGA cluster rods (intact and damaged) meets the criticality safety requirements of 10 CFR Part 71.

7.0 PACKAGE OPERATIONS

The staff reviewed Chapter 7, “Package Operations” for adequacy to verify that the requirements of 10 CFR Part 71 are being met.

The chapter includes the operations for package loading, unloading, and preparation of the empty package for transport. To support this revision request, Section 7.1.6 contains revised operations for the loading of LEU TRIGA cluster rod spent fuel baskets into the NAC-LWT cask. Section 7.1.6 of Chapter 7 provides operations for loading damaged LEU TRIGA cluster rods and debris into DFCs.

The staff reviewed and evaluated the proposed loading operations for intact and damaged LEU TRIGA cluster rod spent fuel or LEU TRIGA cluster rod debris. On the basis of the evaluation, the staff concluded that the operations are adequate.

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 package operations in Chapter 7 of the application.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The staff reviewed Chapter 8, "Acceptance Tests and Maintenance Program," for adequacy to verify that the requirements of 10 CFR Part 71 are being met.

To support this revision request, Sections 8.1.3.1, 8.1.3.2, 8.1.3.3, and 8.2 were revised to describe the acceptance tests and maintenance program necessary for the leaktight testing of the containment boundary.

The staff agrees that the acceptance tests and maintenance for the NAC-LWT package continues to 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

In addition to the packaging drawings (Condition No. 5(a)(3)(ii)) listed in Section 1.2 of this SER, the CoC has been revised as follows:

Condition Nos. 5.(b)(1)(iv) and 5.(b)(1)(x):

> U_3Si_3 was changed to U_3Si_x to account for minor differences in the stoichiometric ratio of fuel plate materials containing uranium that are not typically precise integer values.

Condition Nos. 5.(b)(1)(vi)(a) Note 5 and 5.(b)(1)(vi)(b) Note 5:

> In U-Zr-Hx, the x was editorially corrected to be a subscript.

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

> The specifications of the TRIGA LEU cluster rods and the definition of damaged TRIGA fuel (elements and cluster rods) was added.

Condition Nos. 5.(b)(2)(vii)(a) and 5.(b)(2)(vii)(b):

> A clarification was provided for the use of the sealed damaged fuel can.

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

> The quantities of the TRIGA LEU cluster rods (intact and damaged) was added.

Condition No. 5.(c):

> The CSI for the TRIGA LEU cluster rods (intact and damaged) was added. The formatting of this condition was modified for clarification.

Condition No. 6.:

The conditions listed were corrected.

Condition No. 12.:

This condition was modified to add the TRIGA LEU cluster rods.

Condition No. 16.:

This condition was added to require the sealed DFCs and the leaktight boundary for the damaged TRIGA fuel.

Condition No. 19:

Allows the use of Revision 46 of this certificate for one year.

An editorial change was made in several places throughout the certificate. The units "MWD/MTU" and "GWD/MTU" were changed to "MWd/MTU" and "GWd/MTU."

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. 47,
on May 29, 2008.