July 31, 2006

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

SUBJECT: REVISION 41 OF CERTIFICATE OF COMPLIANCE NO. 9225 FOR THE MODEL NO. NAC-LWT PACKAGE

Dear Mr. Patko:

As requested by your letter dated April 17, 2006, as supplemented June 9 and June 15, 2006, enclosed is Certificate of Compliance No. 9225, Revision No. 41, for the Model No. NAC-LWT package. You requested additional contents and introduction of a new basket assembly for the Model No. NAC-LWT package. 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) 415-8500.

Sincerely,

/RA/

Christopher M. Regan, Acting Chief
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9225
TAC No. L23964

Enclosures:
1. Certificate of Compliance No. 9225, Rev. No. 41
2. Safety Evaluation Report
3. Registered Users

cc w/encl 1 and 2: R. Boyle, Department of Transportation
J. Shuler, Department of Energy
RAMCERTS
Registered Users

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SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT Package
Certificate of Compliance No. 9225
Revision No. 41

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SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT Package
Certificate of Compliance No. 9225
Revision No. 41

SUMMARY

By application dated April 17, 2006, as supplemented June 9 and June 15, 2006, NAC International (NAC) requested that the Nuclear Regulatory Commission (NRC) approve a revision to Certificate of Compliance (CoC) No. 9225 for the Model No. NAC-LWT package to incorporate as approved contents the Australian Nuclear Science and Technology Organization's (ANSTO) spiral fuel (also referred to as Mark III spiral fuel) and MOATA plate bundles contained in the ANSTO basket modules.

The ANSTO basket assembly is introduced in this request and consists of a top and base module with four intermediate modules capable of holding up to seven spiral fuel assemblies or MOATA plate bundles placed in individual fuel tubes that create each basket module weldment. The total approved contents is up to 42 spiral assemblies and up to 42 MOATA plate bundles, or any combination of both up to 42.

A testing requirement for sealed canister designs prior to underwater application was also added to the "Acceptance tests and Maintenance Program" in Chapter 8 of the Safety Analysis Report (SAR). Chapter 7, "Package Operations," of the SAR was also revised to describe the procedure for dry loading of spiral fuel assemblies and MOATA plate bundles and to include wet and dry unloading of the ANSTO fuel basket contents.

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

Four new license drawings were included in this submittal to define the ANSTO fuel basket modules and the Transport Cask Assembly for spiral fuel assembly and MOATA plate bundle shipment.

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."

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 April 17, 2006.

NAC International, supplements dated June 9 and June 15, 2006.

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. The overall dimensions of the package, with impact limiters, are 232 inches long by 65 inches in diameter. The cask body is approximately 200 inches in length and 44 inches in diameter. The cask cavity is 178 inches long and 13.4 inches in diameter. The volume of the cavity is approximately 14.5 cubic feet. The maximum weight of the package is 52,000 pounds and the maximum weight of the contents and basket is 4,000 pounds.

1.2 Packaging Drawings

The applicant submitted four new license drawings. The new drawings included:

LWT 315-40-139, Rev. 0	Transport Cask Assembly, ANSTO Fuel
LWT 315-40-140, Rev. 0 (Sheets 1-2)	Weldment, 7 Cell Basket, Top Module, ANSTO Fuel
LWT 315-40-141, Rev. 0 (Sheets 1-2)	Weldment, 7 Cell Basket, Intermediate Module, ANSTO Fuel
LWT 315-40-142, Rev. 0 (Sheets 1-2)	Weldment, 7 Cell Basket, Base Module, ANSTO Fuel

The drawings were added to define the ANSTO fuel basket modules and the Transport Cask Assembly for spiral fuel assembly and MOATA plate bundle shipments.

1.3 Contents

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

- up to 42 spiral fuel assemblies (also referred to as Mark III spiral fuel)
- up to 42 MOATA plate bundles
- any combination of individual ANSTO basket modules containing either spiral fuel assemblies or MOATA plate bundles up to a total of 42 assemblies/bundles

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 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 Structural Review Description

The applicant requested shipment of up to 42 spiral fuel assemblies and up to 42 MOATA plate bundles or any combination of both up to a total of 42 fuel assemblies/ bundles to be contained in newly designed ANSTO basket modules. The overpack or the transport cask assembly of Model No. NAC-LWT which encloses the fuel basket modules remains unchanged. The ANSTO fuel basket modules, as shown in Drawing Nos. 315-40-139, 140, 141 and 142, each consists of 7 fuel tubes welded to one base plate and 6 support plates. The basket is assembled by 6 modules: one top module, one base module, and 4 intermediate modules (see Drawing No. 315-40-139). In order to show that the shipment of spiral fuel and plate bundles in the NAC-LWT overpack will provide adequate safety margins during the transport, the applicant performed hand calculations on the stresses that occur in the ANSTO basket modules during normal conditions of one-foot drops and hypothetical accident conditions of 30-foot drops. The analysis includes various loading conditions such as internal pressure, thermal stress induced by temperature differentials, hypothetical side drop and end drop impact conditions. The applicant has assumed linear elastic behavior of the material and assumed deceleration loadings of 49.7g in the side and 60g in the end drop orientations, respectively, for the structural evaluation. The safety margins for the structural components of the basket modules are evaluated based on ASME Section III NB Codes.

2.2 Material Properties

The NAC-LWT cask body consists of Type 304 stainless steel forgings and closure lid with Type XM-19 stainless steel shells. Type XM-19 is a high strength stainless steel and is used in the inner and outer structural shells. These materials have been previously approved by the NRC staff.

The staff reviewed the information contained in the revision request and the information presented in the engineering drawings to determine whether the NAC-LWT system with the new payload meets the requirements contained in 10 CFR Part 71. In particular, the following aspects were reviewed: material selection for the basket, applicable codes and standards for the basket, weld design and specification for the basket, and the content (i.e., fuel types).

The ANSTO basket is primarily fabricated from SA 240 Type 304 stainless steel. This type of steel was selected because of its high strength, ductility, resistance to corrosion and metallurgical stability. Because there is no ductile-to-brittle transition temperature in the range of temperatures expected to be encountered prior to or during transport, the susceptibility of Type 304 stainless steel to brittle fracture is negligible.

The cask is analyzed for the transport up to 42 spiral fuel assemblies; up to 42 MOATA plate bundles; or any combination of individual ANSTO basket modules containing either spiral fuel assemblies or MOATA plate bundles up to a total of 42 assemblies/bundles.

The staff reviewed all the fuel types, parameters and the definitions relating to how failed and damaged fuel are defined for this application using the guidance in Interim Staff Guidance (ISG)-1, Revision 1, "Damaged Fuel." Under this revision request, the applicant stated that spiral fuel assemblies and MOATA plate bundles do not contain damaged fuel assemblies. Further, the spiral fuel assemblies will not be subject to exposure of the fuel meat when non-fuel bearing hardware is removed to accommodate the assemblies being placed in the basket.

Based on the information and engineering drawings presented in the NAC-LWT Revision No. 41 SAR submittal, staff concludes that the materials design of the ANSTO basket modules together with the two kinds of fuel assemblies are acceptable for use in the NAC LWT. The staff agrees that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

2.3 Stress Analysis of ANSTO Baskets Under Various Loading Conditions

Structural analyses were performed by hand calculations using the formulas provided by the books "Formulas for Stress and Strain," by R. J. Roark and W. C. Young, 5th Edition (1975), and "Practical Stress Analysis in Engineering Design," by A. Blake, 2nd Edition (1990). Stresses and buckling load formulas provided by the two books for shells (tubes), plates, curved beams and columns were utilized.

Inertial Loadings on the ANSTO Basket Body

The weights of the ANSTO basket and the payload are 911 lbs and 756 lbs, respectively (see Table 2.2.0-1 on page 2.2-2). The weights of the empty packaging (including the ANSTO basket) and the loaded packaging (including the ANSTO fuel and basket) are 48,119 lbs and 48,875 lbs, respectively (see Table 2.2.0-2 on Page 2.2-3). The axial center of gravity location is at approximately 100 inches above the reference base regardless of loading or empty configurations. Since the new design of the basket and contents do not alter the dynamic characteristics very much, the analysis assumes the inertial loadings of normal one foot drop and HAC of 30-foot drops remain unchanged as documented in Table 2.6.7-34 on page 2.6.7-143 (Note that the applicant chose to use a 31-foot drop in this table). For example, the 1-foot side drop will induce a dynamic loading of 24.3 g, and a top-down end drop loading of 15.8 g. For the HAC of 30-foot drops, the loads are 49.7 g for lateral vs. 60 g for longitudinal. In theory, the dynamic loading should be different due to the new design, which may alter the interfacial dynamic properties between the cask and the basket. The staff agrees that the g-load should not deviate too far from what is recorded in Table 2.6.7-34 because the dominate factors such as the weight distributions, center of gravity locations, and impact limiters are exactly or approximately the same.

Normal 1-Foot Drop Loading

The bending stress at the fuel tube produced by the 1-foot side drop normal conditions of 25 g was evaluated conservatively assuming the tube is a diametrically loaded ring using Table 17, case 1 of the Roark book. The maximum bending stress that occurred in the tube was 23 ksi with a margin of safety (MS) of 0.26 for the Type 304 stainless steel at 350EF (its design stress intensity is 19.4 ksi). The bearing stress in the support plate was calculated from Table 33, case 2c of the Roark book. The maximum stress was 3.6 ksi with a MS=5.06 for the material at 350EF (its yield strength is 21.8 ksi).

For the 1-foot end drop with 20 g, the maximum membrane stress occurred at the bottom of the tube joining the support plate, and was calculated as 5.97 ksi based on the total net area of 5.93 in^2 (see page 2.6.12-101 and page 2.7.7-79). The MS is 2.2 for the material with 19.4 ksi of design stress intensity. The stress in the weld amounts to 0.9 ksi with substantial MS even at a high g-load of 60 g. However, because of the 0.3 inch gap at the joint, a bending moment at each circumferential tube base was established with a moment arm of D/π or 1.39 inches. With a dynamic load of 35,400 lbs, the bending moment at each weld would be 7,043 in-lbs. The resulting bending stress (y = 2.98 in, I = 2.09 in^4), 10.042 ksi, is much higher than the original calculated value of 0.9 ksi. Staff agrees that there is still an adequate MS. Thus, it is concluded that the side and the end drop orientations produce the two extreme loading conditions and have been used for the stress evaluation by the applicant.

Thermal Stress Induced by Temperature Gradient

The stresses induced at the joint between the fuel tube and the support plate due to temperature differential were calculated from Table 17, case 1 of the Roark book assuming the tube is a ring. Due to ΔT=230EF (tube temperature=300EF, room temperature=70EF) and ΔT=144EF between the support plate temperature (214 EF) and room temperature (70 EF), the maximum thermal stress due to bending was calculated as 3.9 ksi. After combining this with the mechanical stress of 23 ksi, the MS was 1.16 for the SS 304 with design stress intensity of 19.4 ksi at 350EF.

Hypothetical Accident 30-Foot Drop Loadings

Structural analysis for the ANSTO basket for 30-foot side and end drops was performed using hand calculations based on Table 17, case 1 of the Roark book. For the side drop case, the maximum bending stress occurred at the outer fiber of the tube overhanging the support plate. For a 60 g load of 5,796 lbs, the circumferential bending stress was 52.2 ksi, and the longitudinal bending stress was 2.5 ksi, resulting in a combined stress of 54.7 ksi. The MS becomes 0.20 for the tube with ultimate strength of 65.6 ksi, according to the ASME Codes.

For the end drop case, the inertial load of 60 g produced a dynamic load of 106,200 lbs. Using the net area calculated as before for the 7 tubes (A= 5.93 in^2), the maximum membrane stress at the tube joining the base plate was 17.9 ksi. Thus, the MS calculated according to the ASME Code was 1.5 for an ultimate strength of 65.6 ksi.

Localized buckling of a fuel tube was also evaluated using the methodology presented in the Blake book (see Equation 37.19 on page 556). The calculated critical buckling stress for the tube was 160 ksi. Since this stress is much less than the maximum bending stress that occurs during the 30-foot end drop (17.9 ksi), the applicant concluded that the tube would remain stable during the drop.

2.4 Stress Analysis of Spiral Fuel Assemblies

The spiral fuel assembly consists of a central tube, an outer tube, and 10 curved plates, 25 inches long. Stresses in the center tube and the outer tube, which are constructed of Aluminum 1100 (Al-1100) produced by the inertial loads were evaluated using Table 17, case 15 in the Roark book on the per unit length basis.

<u>Center Tube</u>

The applicant assumed that the weight of the 10 curved plates was shared equally between the center and outer tubes. Thus, during the basket side drop, the weight or load on the center tube per unit length was 0.0058 lb per inch before taking the dynamic effects into account. For the case of normal condition one-foot side drop of 25 g loading, the maximum circumferential bending stress in the center tube was 2.8 ksi. Accordingly, the MS calculated according to the ASME Code was 0.58 for the Al-1100 material at 250 EF with design stress intensity of 2.95 ksi.

For the case of HAC 30-foot side drop, the 60 g load created a maximum bending stress of 6.7 ksi. The MS calculated according to the ASME Code was 0.36 for the Al-1100 material with an ultimate strength of 9.14 ksi at 250EF.

<u>Outer Tube</u>

The formula of curved beam or pinned arch subjected to a uniform load is used for the stress analysis for the outer tube. The weights of the center tube, 10 plates, and the outer tube are 1.0582, 4.431 and, 2.425 lbs, respectively. Thus, the dynamic load of 60 g due to the HAC 30-foot drop was 1.53 lb per unit length of circumference. The maximum bending stress in the outer tube due to the HAC was 879 psi according to Equations 27.63 and 28.1 of the Blake book. The MS was, therefore, 4.0 computed from the ASME Code using the design stress intensity of 2.95 ksi for the Al-1100 at 250EF.

2.5 Stress Analysis of MOATA Plate Bundles

The MOATA plate bundle consists of two 6.35-mm thick aluminum plates and 9 or 14 aluminum fuel plates sandwiched in between. At both ends, the end fittings are 3.449 inches in outer diameter; therefore, the side drop orientation is the worse case scenario.

<u>Side Drop</u>

For a 30-foot side drop HAC, the maximum stress in the 6.35 mm aluminum plate was calculated by assuming the plate was a uniformly loaded, simply supported beam. The 60 g load created a bending moment at the center of the beam of 62.5 in-lb, which translated to a bending stress of 6.0 ksi for the one quarter inch plate. Using the ultimate strength of 34.6 ksi for the 6061 T-6 aluminum material at 250EF, the ASME Code gave a MS of 1.9.

At the 90 degree orientation for the 30-foot side drop, the fuel plates are not supported by these two thick aluminum plates. The stresses in the Al-1100 fuel plates need to be addressed. Modeling the plates as a uniformly loaded and simply supported beam, the bending moment at the middle of the beam as 129.3 in-lbs due to the 60 g load. This translates into a maximum stress of 1.1 ksi with a MS equaling 3.0 when the design stress intensity is 2.95 ksi for Al-1100 at 250EF.

End Drop

During an end drop, a compressive stress is developed within both the aluminum plates and the fuel plates. For a 60 g end drop, the total load on one end plate was 130.2 lbs. This translates to a membrane compressive stress of 154 psi. The critical stress for buckling of this 26 inch long plate was evaluated from the Euler buckling theory which yields 371 psi. The safety factor against buckling was 2.4 (371/154). Thus, the two outside aluminum plates will not buckle. Consequently, the 9 or 14 fuel plates between the two aluminum plates cannot buckle during the HAC end drop situation. The membrane compressive stress in the fuel plate was 166 psi which is too small to cause damage.

2.6 Conclusions

The staff verified the formulae used by the applicant and performed confirmatory hand calculations which agreed with the applicant’s results. Staff also reviewed the material properties, allowable values for stress, and critical buckling loads.

Based on the analyses presented in the NAC-LWT Revision No. 41 SAR submittal, staff concludes that the contents in the cask in the newly designed ANSTO basket modules together with the two kinds of fuel assemblies will provide adequate margins of safety during normal conditions of transportation and hypothetical accident conditions. The staff agrees that the changes do not affect the ability of the package to meet the structural integrity 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 Normal Conditions of Transport

The applicant used the ANSYS finite element analysis program to model the thermal design of the MOATA and spiral fuel in the NAC-LWT for NCT. The applicant used several conservative assumptions and referred to prior thermal analyses. The analyses determined maximum component temperatures for NCT as listed in the following table:

T_{max} (EF) for NCT
($T_{allowable}$ EF)

Fuel Type/Heat Load	**Fuel**	**Basket**
MOATA (126 Watts)	233EF (400EF)	230EF (800EF)
Spiral (756 Watts)	250EF (400EF)	248EF (800EF)

The staff reviewed the ANSYS analyses and the thermal performance of other contents and components previously licensed that the applicant used as bounding analyses. The staff found reasonable assurance that the content and component temperatures are acceptable for MOATA and spiral fuel types.

The previous analyses submitted for the maximum normal operating pressure for the package were not changed and bound this revision request.

3.2 Hypothetical Accident Conditions

The applicant referred to previous content analyses (MTR fuel) that bound the contents of this application. Specifically, the maximum heat load of the MTR fuel (0.756 kW per cask) is bounded by the maximum heat load of the MTR fuel (1.05 kW per cask). The temperature of the inner shell for the accident condition obtained from the MTR evaluation was then conservatively used in the analyses to determine maximum component temperatures for HAC as listed in the following table:

T_{max} (EF) for HAC
($T_{allowable}$ EF)

Fuel Type/Heat Load	**Fuel**	**Basket**
MOATA (126 Watts)	345EF (400EF)	342EF (800EF)
Spiral(756 Watts)	362EF (400EF)	360EF (800EF)

The staff found reasonable assurance that the content and component temperatures are acceptable for MOATA and spiral fuel types for hypothetical accident conditions.

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 with the MOATA and spiral fuel contents 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 containment boundary of the NAC-LWT package consists of a 4.0-inch-thick bottom plate, a 0.75-inch-thick, 13.375 inch inner diameter shell, an upper ring forging, and an 11.3-inch-thick closure lid. The cask lid is 11.3-inch-thick stainless steel stepped design, secured to a 14.25-inch-thick ring forging with twelve 1-inch diameter bolts. The cask containment boundary seal is a metallic O-ring. A second teflon O-ring and a test port are provided to leak test the seal. Other penetrations in the cask cavity include the fill and drain ports, which are sealed with port covers and O-rings. Neutron shielding is provided by a 5.0-inch-thick neutron shield tank with a 0.24-inch-thick outer wall, containing a water/ethylene glycol mixture that is 1.0 weight percent (wt %) boron.

4.2 Containment Evaluation

In support of the revision request, the applicant submitted a containment evaluation to show that the MOATA and spiral ANSTO fuel assemblies are bounded by the DIDO fuel listed in 5(b)(1)(x) of the certificate. The spiral and MOATA fuel are comprised of plate fuel, similar to the MTR and DIDO fuel. The applicant’s containment evaluation shows that, for the same decay heat (18 Watts), when the spiral fuel assemblies are limited to the cool time curve for the medium enriched DIDO fuel assemblies, the source term for a spiral fuel assembly is lower than for a DIDO fuel assembly, due to the DIDO’s higher fissile mass. Additionally, the applicant has shown that the lower burnup and longer cool time for the MOATA fuel assemblies produces a lower source term than the DIDO fuel.

4.3 Conclusion

Based on the statements and representations in the application, staff agrees that the applicant has shown that the NAC-LWT filled with either spiral fuel or MOATA fuel is bounded by the DIDO fuel and meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING

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 Evaluation

The applicant performed a shielding evaluation to show that the Spiral and MOATA fuel assemblies are bounded by the DIDO fuel assemblies listed in 5(b)(1)(x) of the certificate. The applicant used the Shielding Analysis Sequence No. 2 Enhanced Version (SAS2H) sequence in the Standardized Computer Analyses for Licensing Evaluation (SCALE) system to determine the bounding source term for both the Spiral and the MOATA fuel assemblies. The applicant then compared the neutron and gamma source terms, for each energy group to the source term determined for the medium enriched DIDO fuel assemblies.

The applicant calculated the source terms for the spiral fuel assemblies for fuel depletions for each decade from 10 through 70 percent. The applicant decayed each of the burnup calculations the minimum amount of time to yield a decay heat of 18 watts. The bounding source term was for a fuel depletion of 70 percent. The comparison between the two fuel assemblies show that for the number of gammas and neutrons per second are very similar for the energies between 0.5 and 2.5 MeV, which are the energies of importance for dose calculations.

The applicant also provided a comparison of the minimum decay time as a function of burnup to produce 18 watts of decay heat. For every point on the graph, the minimum decay time for the spiral fuel is less than the DIDO medium enriched fuel; therefore, as long as the spiral fuel has the same minimum cool time as the DIDO fuel, the spiral fuel source term will be bounded by the DIDO fuel. Since the enrichment of the spiral fuel is less than the medium enriched DIDO fuel, the neutron source term will also be bounded. Additionally, the neutron doses for the DIDO fuel are much smaller than for the gamma doses.

The applicant also determined the source term for the MOATA fuel assemblies for 36,000 MWD/MTU and the minimum cool time of 10 years. For each group in the gamma energy spectrum, the MOATA fuel source term is significantly less than the DIDO fuel. Since the enrichment of the MOATA is less than the medium enriched DIDO fuel, the neutron source term will also be bounded.

5.2 Conclusion

Based on review of the statements and representations in the application, the staff concludes that the applicant has shown that the shielding design for the NAC-LWT containing either the spiral fuel or MOATA fuel has been adequately described and evaluated 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 package 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 Evaluation

NRC staff performed a criticality safety review of the proposed revision for the NAC-LWT cask to incorporate as approved contents, up to 42 spiral fuel assemblies and up to 42 MOATA plate bundles, or any combination of both up to a total of 42 assemblies/bundles to be contained in ANSTO basket modules. The staff evaluated the proposed addition of the new fuel types based on information provided in the proposed revised CoC supplied by NAC against the regulatory requirements of 10 CFR Part 71.

The applicant employed conservative assumptions to trend the reactivity effects of various configurations of fuel types in order to produce a bounding fuel assembly characteristic set. A range of varying density moderator was evaluated and the optimum used in all calculations. The ANSTO basket models used are very similar to the already approved DIDO baskets, but utilize slightly larger and thicker fuel tubes and have eliminated the aluminum heat transfer components.

The applicant considered internal moderation to the most reactive extent by varying the water density in the void spaces of the cask cavity. The ANSTO basket does not contain neutron poison materials. The analyses were performed for infinite arrays of packages under normal and accident conditions, therefore the CSI is 0.0.

For the spiral fuel assemblies the applicant utilized a minimum active fuel height in lieu of the typical maximum active fuel height. This was done to reduce the overall space between fissile material analyzed for the axially alternating shifted model. The end fitting structure of the plate bundle will ensure the separation between active fuel regions. The MOATA fuel utilizes a nominal active fuel height.

Analyses were performed by the applicant to encompass credible fuel configurations, including normal and hypothetical accident conditions to ensure that the effective multiplication factor (k_{eff}) was below 0.95 for all analyzed configurations of spiral fuel assemblies, MOATA plate bundles, and mixed ANSTO basket loadings, including corrections for bias and uncertainty. The applicant used the KENO V.a package included with the SCALE criticality sequence computer code package using the 27GROUPNDF4 cross-section library for fissile media in their calculations.

NRC staff also reviewed the applicant's reduction in clad thickness of DIDO elements from 0.0325 cm to 0.025 cm. The applicant performed calculations that repeated the previously submitted calculations substituting in the reduced clad thickness. This demonstrated that while there was an increase in the maximum reactivity of the system, the increase was slight and within the k_{eff} limit of 0.95 when configured in the infinite cask array. In conjunction with the reduced clad thickness, the applicant parametrically evaluated the reactivity effects of pitch within DIDO elements and established that the maximum reactivity configuration was also within established subcritical limits for the infinite array.

NRC staff performed confirmatory calculations on the bounding configurations for the ANSTO basket loadings utilizing the SCALE package of codes using conservative assumptions and found that in all cases the calculated multiplication factor was less than the standard 0.95 criteria and in agreement with the findings of the applicant.

6.2 Conclusion

Based on the statements and representations in the application, as revised, the applicant has shown that the NAC-LWT cask containing either spiral fuel assemblies or MOATA plate bundles in any combination up to 42 total assemblies/bundles in an ANSTO basket as well as the reduction in the cladding thickness for DIDO elements 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 7.1.4 of the SAR was revised to include the procedure for the dry loading of the spiral fuel assemblies and MOATA plate bundles into the NAC-LWT cask. Sections 7.2.3 and 7.2.4 were also revised to include wet and dry unloading of the ANSTO fuel basket contents.

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, Section 8.1.4.3 of the SAR was added to describe the addition of the testing requirement for sealed canister designs prior to underwater application.

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

In addition to the packaging drawings (Condition No. 5(a)(3)(ii)) listed in Section 1.2 and the authorized contents listed in Section 1.3 of this SER, the CoC has been revised as follows:

Condition No. 5(a)(2):

> The spiral fuel assemblies and the MOATA plate bundles were added to the description of the Model No. NAC-LWT.

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

> The minimum fuel clad thickness for the DIDO fuel elements was reduced from 0.0325 cm to 0.025 cm in accordance with the evaluation in Section 5.1 of this SER. The minimum nominal inner diameter was changed to the minimum inner diameter for clarity.

Condition Nos. 5(b)(1)(xiv):

> Details on the type and form of material were added for the additional contents of spiral fuel assemblies and MOATA plate bundles.

Condition Nos. 5(b)(2)(xv):

> Provides for the maximum quantity of material per package for the additional contents of spiral fuel assemblies and MOATA plate bundles.

Condition No. 5(c)(1):

> Spiral fuel assemblies and MOATA plate bundles were added to the contents with a criticality safety index of 0.0.

Condition No. 11:

> The spiral fuel assemblies and the MOATA plate bundles were added to the requirements for the neutron shield tank.

Condition No. 12:

> The spiral fuel assemblies and the MOATA plate bundles were added to the requirements for a personnel barrier.

Condition No. 19:

Allows the use of Revision 40 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. 41,
on July 31, 2006.