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

August 8, 2014

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

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9225, REVISION NO. 60, FOR THE MODEL NO. NAC-LWT PACKAGE (TAC NO. L24875)

Dear Mr. Patko:

As requested by your application dated December 31, 2013, as supplemented on May 30, 2014 and July 15, 2014, enclosed is Certificate of Compliance No. 9225, Revision No. 60, for the Model No. NAC-LWT transportation package. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's safety evaluation report is also enclosed.

The 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 Title 49 of the *Code of Federal Regulations* (49 CFR) 173.471. 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.

Sincerely,

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

Docket No. 71-9225
TAC No. L24875

Enclosures:
1. Certificate of Compliance No. 9225, Rev. No. 60
2. Safety Evaluation Report
3. Registered Users

Upon removal of Enclosure 3, this document is uncontrolled

cc w/encls. 1& 2: R. Boyle, Department of Transportation
J. Shuler, Department of Energy c/o L. F. Gelder

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OFC:	SFST	SFST				
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WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT
Certificate of Compliance No. 9225
Revision No. 60

SUMMARY

By application dated December 31, 2013, as supplemented on May 30 and July 15, 2014, NAC International (NAC or the applicant) requested a revision to Certificate of Compliance (CoC) No. 9225 for the Model No. NAC-LWT (NAC-LWT) transportation package. The application requested a change to incorporate new Material Test Reactor (MTR) fuel parameters accommodating Australian Nuclear Science and Technology Organisation (ANSTO) Open Pool Australian Lightwater (OPAL) reactor fuel. The major changes for the MTR payload are:

1. Allowing ≤ 23.5 g uranium-235 (U-235) content per plate for an active fuel width of ≤ 7.0 cm provided the plate thickness is ≥ 0.130 cm, the active fuel width is ≤ 7.0 cm, the active fuel height is ≥ 56 cm and the U-235 content per element is 490 g; and
2. Raising the maximum decay heat limit from 30 watts per element to 40 watts per element, limited by the current package heat load limit of 1.26 kilowatts and 210 watts per MTR basket module.

The staff performed its review of the applications, as supplemented, 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, the U.S. Nuclear Regulatory Commission (NRC) staff finds that these 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

3.0 THERMAL EVALUATION

The staff reviewed the NAC-LWT amendment application to verify that the thermal performance of the package has been adequately evaluated for the tests specified under normal conditions of transport (NCT) and hypothetical accident conditions (HAC) and that the package design satisfies the thermal requirements of 10 CFR Part 71. The application was also reviewed to determine whether the package fulfills the acceptance criteria listed in Section 3 of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel," as well as associated Interim Staff Guidance (ISG) documents.

The amendment application incorporates new MTR fuel parameters. The MTR fuel change that affects the cask thermal performance is an increase in the decay heat limit from 30 watts per element to 40 watts per element. However, the package decay heat limit remains unchanged at 1.26 kW and 210 watts per MTR basket module. The applicant performed the thermal analysis for the increased decay heat using previously approved finite element analysis methods. The applicant's analysis results provided in Table 3.4-6 of the application indicate that the calculated maximum MTR fuel temperature remains below the acceptable limit of 400°F with adequate margin. This limit is established in the application as the maximum allowable limit for MTR fuel cladding temperature for NCT. The bases for this limit are provided in the application and remain unchanged in this amendment request. For HAC (fire), the applicant performed the analysis using previously approved finite element analysis methods. The maximum temperatures reached during HAC are presented in Table 3.5-2 of the application. The applicant's analysis results demonstrate that the maximum MTR fuel cladding temperature is 473°F which is below the applicant's established limit of 500°F. The bases for this limit are provided in the application and remain unchanged in this amendment request.

The staff reviewed the amendment application for changes that affect the cask thermal response. The staff also reviewed the updated thermal analysis provided in the application and the analysis results to verify the results are below established limits. Based on review of the statements and representations in the application, the staff concludes that the NAC-LWT thermal design has been adequately described and evaluated, and that the thermal performance of the package meets the thermal requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The purpose of the shielding review is to verify that the package design meets the external radiation requirements of 10 CFR Part 71 for NCT and HAC. The applicant proposes to modify the specifications for the allowable MTR fuel contents. In particular, the applicant proposes to increase the maximum U-235 mass per fuel element to 490 grams for all the low enriched uranium (LEU) MTR fuel described in the CoC Condition No. 5(b)(1)(iv)(c), to add a new fuel element to that condition that has fuel plates of minimum thickness of 0.130 cm, a maximum active width of 7.0 cm, and a maximum U-235 mass per fuel plate of 23.5 grams. In addition, the applicant proposes to increase the maximum heat load per fuel element for which preferential loading is not required. The staff reviewed the submittal using the guidance in Section 5 of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material" and NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

5.1 Description of the Shielding Design

5.1.1 Packaging Design Features

The design of the packaging remains unchanged from the design approved in previous revisions of the CoC. One change, however, was made to the design CoC drawings. This change was to make the drawing specification for the liquid neutron shield consistent with the CoC Condition No. 5(a)(2) description of the shield with regard to boron concentration. The staff reviewed the change and finds it is acceptable for meeting the CoC condition regarding the boron content. The staff also reviewed the change in terms of the effects on the hydrogen content in the neutron shield and ensuring the amount is at least consistent with the amount relied upon in the shielding analysis. Based on the composition of the other shield constituents and the information in the applicant's response to staff questions regarding the shield composition, the staff has reasonable assurance that the shield composition is at least consistent with what was used in the shielding analysis for the constituents other than boron.

5.1.2 Summary of Maximum Radiation Levels

The applicant continues to use the dose rates for the preferentially loaded high enriched uranium (HEU) MTR fuel to demonstrate that the dose rate limits are met. The applicant states in the safety analysis report (SAR) that the dose rates from LEU MTR fuel with the proposed new specifications are bounded by or statistically equivalent to the HEU dose rates (shown in the SAR Tables 5.3.4-9 through 5.3.4-15). Compliance is demonstrated for exclusive use shipment within an enclosure. For MTR fuel, the enclosure is an ISO container. The CoC is conditioned to require MTR fuel shipments be made with the package in an ISO container, as opposed to in a personnel barrier or open transport. The applicant did provide a calculation package that includes the dose rates calculated for LEU fuel with the proposed specifications. The staff reviewed those dose rates and finds they are very similar to or bounded by the HEU dose rates. The most limiting dose rate is the radial dose rate at 2 meters from the conveyance (ISO container) surface. The application and calculation package show the HEU dose rates are bounding for this location.

5.2 Source Specification

The proposed contents are MTR fuel elements with the specifications described earlier in this section of the SER. In addition, the proposed contents have decay heat up to 40 watts per element and may be loaded into any fuel basket location. The maximum burnup varies up to but does not exceed 80% (i.e., 139.3 GWd/MTU) while the minimum cooling time varies down to but no less than 90 days. In addition the minimum cooling time for the already approved contents was modified to vary down to no less than 90 days. The variation in burnup and cooling time is to ensure compliance with the proposed heat load limits for the different MTR contents, including the proposed contents.

The applicant used SAS2H to determine the cooling time and burnup combinations that would result in the contents having specified decay heat values and to determine the radiation source terms for those cooling time and burnup combinations. For the proposed new LEU MTR contents, this included the decay heat limit of 40 watts. Calculations were also performed to determine the cooling time and burnup combinations that resulted in 10, 20, and 30 watts for the proposed new contents.

The applicant used the same MTR physical parameters as for the calculations that support the currently approved contents. The applicant provided justification for using the same model. The justification includes fuel composition, the model parameter values versus the LEU content specifications in and proposed for the CoC, and the code's calculation method.

The staff reviewed the applicant's justification and also performed independent evaluations of the specifications of the proposed contents versus the SAS2H model's parameters. Based on this review and these independent evaluations, selection of a different fuel matrix material (which may be aluminum, oxide, or silicide based) will have very little to insignificant impact. As part of its evaluations, the staff performed its own source term calculations using SAS2H to understand the impacts of differences in the parameters specified in the CoC for LEU MTR fuel. For these calculations, the impacts of changes to individual parameters and some combinations of parameters were considered. These calculations indicate that the parameter values used in the applicant's model result in bounding source terms. For those that are not bounded, consideration in combination with other parameters in the same column of specifications in the CoC Condition No. 5(b)(1)(iv)(c) indicates the applicant's model would result in bounding source terms. The staff also performed analyses which combined parameter variations that resulted in source terms that are not bounded by the applicant's model. This analysis is discussed later in this SER.

In performing this analysis, the staff had questions regarding some of the assumptions built into the applicant's source term calculation and about the need for the CoC to specify parameter limits in Condition No. 5(b)(1)(iv)(c) such as maximum values on parameters where only minimum values are currently specified. However, other assumptions in the applicant's model introduce conservatisms into the calculations. These include applying a uniform power history throughout the depletion. Additionally, the staff considered the practical considerations, as noted by the applicant, for how variations of one parameter in the fuel design affect other parameters, as well as the nature of how MTR reactors are operated. For example, the periods of time of irradiation and decay in the reactor to reach even low burnup levels takes significantly longer than those used in the model. This results in the model over-predicting the radiation source term, since the time periods in the model allow for less decay of the radionuclides than the time periods associated with actual reactor operations. Therefore, based on a review of the information provided by the applicant and its independent evaluations, the staff finds the method for calculating the source terms, including the model, to be acceptable.

The applicant used the neutron and gamma source terms for the maximum burnup allowed for the proposed contents (i.e., 80%, or 139.3 GWd/MTU). These source terms are specified in Tables 5.3.4-16 and 17 of the application. The applicant included some analysis to demonstrate that the source terms for this burnup at the proposed decay heat limit of 40 watts per element, resulted in bounding dose rates. The staff also performed analyses of different burnup and cooling time combinations for the same decay heat. Based upon the applicant's analysis and the staff's independent calculations, the staff finds that the source terms for the maximum allowed burnup at the proposed decay heat limit will yield bounding dose rates.

5.3 Model Specification

5.3.1 Configuration of Source and Shielding

The applicant used the same model and configuration for the shielding analyses as for analyses of currently approved MTR contents. However, the applicant did provide more information regarding the configuration since some aspects of the configuration were not clear from the information already in the safety analysis report.

The applicant used the SAS4H module of the SCALE code system. Thus, the applicant's models are based, in part, on the input requirements for the code. This includes assumptions of axial symmetry about the package's axial midplane. Thus, the model is only of the top half of the package. The top half was selected because the package has less shielding at the axial top end than it does at its axial base. Also, the package cavity extends beyond the package's radial lead shielding, which is not the case at the base of the package. Thus, the model will capture the areas of maximum dose rates for the package. The thicknesses of the shielding materials in the package model are consistent with dimensions in the package drawings, though they are nominal dimensions and do not account for tolerances.

The package dose rates are analyzed for shipment of the package in an enclosure, an ISO container, under exclusive use conditions. Thus, the NCT model accounts for the dimensions of an ISO container, which affect the placement of detectors in the model with respect to the package. The ISO container is 20 feet long by 8 feet wide. The package is centered within the container. The NCT model conservatively neglects the package's impact limiters. The HAC package configuration is the same as the NCT model except that the neutron shield is neglected in the HAC configuration. Lead slump is not accounted for in the models based upon the fabrication technique for the lead shielding in the package, which is conducted to ensure the lead material completely fills the shield cavity.

As for the packaging, the applicant used the same configuration of the source, the package contents, as in previous analyses. The position of the MTR elements is based upon the presence of end hardware (made of aluminum) of the length considered in an earlier analysis. With that hardware length, the position of the MTR elements is against the top of the package cavity. However, since that earlier analysis, the end hardware is allowed to be cut to shorter lengths. Thus, it would seem that new models should shift the MTR elements closer to the package lid. However, the applicant provided justification for why this is not necessary. The justification includes the modeling assumption of a flat axial profile for the source instead of a profile that is more representative of the actual profile. Thus, the source strength in the model is stronger at the top end of the fuel location than it would otherwise be.

The staff reviewed the applicant's model, including performing some simple confirmatory calculations, described later in this section of the SER. Based upon its review and calculations, the staff finds the applicant's model to be acceptable for the current application.

5.3.2 Material Properties

The staff reviewed the material properties used in the applicant's models as described in the application and the accompanying proprietary calculation package. For the packaging, the materials, other than the neutron shield, are steel and lead. The neutron shield is modeled as a mixture of water and glycol, which neglects the boron in the actual neutron shield. These material properties are the same as for the analyses for the currently approved package. For the package contents, the fuel elements are represented by a mixture of fuel and cladding that uniformly fills the volume occupied by each element. The densities of the material components are scaled by the fraction they occupy of the total fuel element's volume. The staff reviewed the material properties used in the models. The staff finds they are consistent with package and its contents material properties as required to be modified for use in the models. The staff finds, therefore, that the material properties used in the models are acceptable.

5.4 Source Term Calculation Evaluation

5.4.1 Methods

As discussed previously, the applicant performed source term calculations using the SAS2H module of the SCALE code system and dose rate calculations using the SAS4 module of the SCALE code system. The staff notes the applicant has used an older version of the SCALE code system, SCALE 4.3. More recent versions of the SCALE code are available. As the SCALE code has been updated, the data libraries and capabilities of the code have been improved. Also, along the way, features such as SAS4 have been dropped from the code and support for earlier code versions has ceased. Thus users of earlier code versions and no longer supported features have a greater responsibility for issues (e.g., bugs and errors) in the code and having those addressed. However, based on its review, the staff finds reasonable assurance that use of these code modules is acceptable for this application. This finding is based on the staff's approvals of previous revision applications and the proposed contents changes versus the currently approved contents for this package.

5.4.2 Key Input and Output Data

The applicant provided several input and output files for the source term and dose rate calculations. The staff reviewed the information in the application and confirmed the data in the input files are consistent with the descriptions of the models in the application. The staff confirmed that the data used in the input files is appropriate for and consistent with the proposed contents. As stated previously, the applicant uses the same models for the source term and dose rate calculations. The material properties in the models are modified to represent the contents proposed in this CoC revision request.

5.4.3 Flux-to-Dose-Rate Conversion

The dose rate calculations use the default conversion factors for SAS4. These default conversion factors are the ANSI/ANS 6.1.1-1977 conversion factors. The staff finds the use of these factors acceptable as they are the factors recommended in the staff's review guidance.

5.4.4 Radiation Levels

As stated previously, the application continues to use the dose rates calculated for the already approved preferentially-loaded HEU MTR fuel to demonstrate compliance with the regulatory dose rate limits. This is because the applicant's calculations indicated that the dose rates from the proposed contents (LEU MTR fuel with 40 watts and 490 grams U-235 per element) uniformly loaded in the package are bounded by or are statistically equivalent to the dose rates for the preferentially-loaded HEU MTR contents. The safety analysis report, therefore, only shows the HEU contents dose rates. The dose rates of the proposed LEU contents are only shown in the proprietary calculation submitted with the application. The applicant did add new dose rate data for the location 1 meter from the package's axial top end.

The staff reviewed the results in the SAR and the proprietary calculation. The dose rates for both the LEU and HEU contents indicate that the most restrictive limit is the NCT limit at 2 meters from the ISO container surface in the radial direction from the package (i.e., along the package's side). The staff finds the results for the proposed LEU contents are generally bounded by the HEU contents. The peak dose rates on the package radial surface may be slightly higher for the proposed LEU contents; however, they are still significantly below the limit for the package surface and may not be statistically different from the peak HEU dose rates on the package surface. Thus, the staff finds the use of the HEU dose rates to demonstrate compliance with the regulatory limits is acceptable and that the results indicate the limits will be met.

5.5 Staff Confirmatory Analysis

As already described, the staff performed some confirmatory analyses as part of its review. Some of these analyses are described in the previous sections of this SER.

The staff used the SAS2H module of the SCALE code system, Version 5.0, a later version than that used by the applicant, to calculate source terms for various burnup and cooling time combinations of the proposed contents. The staff also used the code to calculate source terms for different variations of the MTR fuel parameters described in the CoC Condition No. 5(b)(1)(iv)(c). The source term calculations for different burnup and cooling time combinations generally supported the applicant's basis for using the source terms for the maximum burnup (80% or 139.3 GWd/MTU) for the shielding analysis.

The staff's calculations, as noted previously, generally supported the applicant's selection of MTR parameters in its models for generating source terms. Some parameter variations did result in higher source terms. The staff performed a calculation for a combination of two of these parameters, the largest fuel width and plate thickness shown the CoC condition. This resulted in a significant increase in the source terms, both neutron and gamma. The staff evaluated the impacts of this source term on the package's ability to demonstrate compliance with the dose rate limits for both axial and radial directions. To do this, the staff used the MicroShield code, Version 9.06

The MicroShield code is a one-dimensional point kernel code that is used for gamma dose rate calculations. The code has a number of limitations to its usefulness in terms of a package such as the LWT. Recognizing these limitations, the staff used the code, in a conservative manner, to primarily understand the impacts (or the relative differences) on gamma dose rates due to different assumptions such as the source term. The staff used the absorbed dose rates calculated by the code and not the effective dose equivalent values that the code also calculates. The absorbed dose rates are more consistent with the method accepted by staff for calculating dose rates from gamma fluence rates. For radial dose rates, the impacts of package tolerances were also included in the model. Only NCT dose rates were considered given the significant margins to the HAC limits.

The staff used these relative differences in gamma dose rates and along with a conservative estimate for relative differences in neutron dose rates to calculate new dose rates for the proposed LEU contents. The relative difference in neutron dose rates was taken to be the relative difference in the neutron source terms (the applicant's model vs. MTR fuel at maximum fuel width and plate thickness). The baseline dose rates are the maximum neutron and gamma dose rates reported for the proposed contents in the proprietary calculation package.

The calculations include similar conservatisms that are in the applicant's model. The impact limiters are ignored. Also, a flat burnup profile is applied to the fuel. Some of the axial calculations did not account for the dimensions of the ISO container. Accounting for the ISO container's dimensions, even assuming that its surface is coincident with the end surface of the impact limiter, the analysis indicates the axial dose rates will meet the limits for NCT exclusive use transport in an enclosure. The analyses for the radial dose rates also indicate that the package will meet the limits in the radial direction. The analysis also indicates that the dose rates in the radial direction are more limiting than the dose rates in the axial direction.

The staff also did a simple calculation to understand the impact of shifting the contents closer to the package lid. This was considered since the fuel elements' end hardware may be cut as short as 0.28 inches per Table 1.2-4 (note 4) of the application. The staff used MCNP, Version 5, 1.3 to do this calculation. The MCNP code is used throughout industry to perform shielding analyses that has the capability to handle complex geometries and to calculate neutron and gamma dose rates. The staff did two gamma dose rate calculations with a very simple model of the contents. The first model placed the contents in the same position as the applicant's model. The second model placed the fuel about 0.28 inches below the package lid. Only gammas were considered, because the areas of maximum dose rates are above the neutron shield in both models. Thus, the neutron dose rate is not anticipated to really change. The model includes similar conservatisms as are in the applicant's model (e.g., flat burnup profile, no impact limiters). The calculations indicate that the dose rates would be significantly impacted by the change in the contents position. However, when a more realistic burnup profile and the other analysis conservatisms are considered, the evaluations indicate that the dose rate limits will still be met.

5.6 Allowable Contents Curves

The applicant used the results of its analysis to develop loading curves for the proposed LEU MTR contents and to modify the curves of the currently approved MTR contents. The curves for the currently approved contents were modified to allow for a minimum 90 day cooling time. The curves for the proposed contents were developed based on calculations for specific burnup and cooling time combinations. Linear interpolation was used to develop the curves from those points for the 40w, 30w, 20w, and 10w element heat loads.

The applicant provided justification to support the acceptability of the interpolation for developing the curves. The curves are one option available to a package user in Chapter 7 of the SAR for determining acceptability of the contents the user proposes to ship. The applicant states that the curves are conservative with respect to heat load, meaning they result in a heat load that is less than the allowed heat load. The staff's source term calculations support that statement. Thus, the staff finds that use of linear interpolation to define the loading curves is acceptable.

The interpolation, though, does not affect the radiation source terms. The applicant used the interpolated cooling time to generate a single time-specific set of neutron and gamma sources. The applicant adjusts the calculation to get the allowable heat load and use the radiation sources for that heat load for the specific burnup. This is done to assure bounding sources and thus bounding dose rates are determined. This is done because the package operations allow the user to determine the acceptability of the contents it proposes to ship by heat load alone (i.e., if the package user knows its LEU MTR fuel element has a decay heat of 40 watts, the element may be shipped since it meets the decay heat limit; the user need not use the loading curves). The staff finds this aspect of the analysis to be acceptable because it ensures bounding dose rates are calculated for the package containing the proposed contents. Because the analysis is performed in this manner, the staff finds acceptable the option of allowing the user to determine its MTR fuel is allowable contents by simply verifying the fuel's decay heat meets the relevant CoC decay heat limit.

5.7 Evaluation Findings

Based on its review of the statements and representations in the application, including the proprietary calculation package and applicant responses to staff questions, and independent confirmatory calculations, the staff has reasonable assurance that the shielding design has been adequately described and evaluated and that the package meets the external radiation requirements of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

The application for amendment to Certificate of Compliance No. 9225 requests permission to transport MTR OPAL fuel with maximum 23.5 grams of U-235 per plate with maximum active fuel width of 7.0 cm, minimal plate thickness of 0.130 cm, and a minimal height of 56 cm. The maximum number of plates per fuel basket is 21 and the maximum total U-235 load per basket is 490 grams.

The applicant provided, in Chapter 6 of the revised SAR, a criticality safety evaluation for the package with the requested content. The staff reviewed these analyses to verify whether these designs meet the transportation package criticality safety requirements of 10 CFR Part 71. The staff followed the guidance provided in Section 6 (Criticality 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,” during its review.

6.1 Criticality Safety Review

Chapter 6 of the SAR provides criticality safety analyses for the MTR fuel packages with a maximum U-235 enrichment of 25 wt%. The maximum quantify of U-235 is 23.5 grams per MTR fuel plate that has a maximum active fuel width of 7.0 cm, minimal thickness of 0.130 cm, and a minimal height of 56 cm. The maximum number of plates per fuel element or fuel basket is 21 for either integral fuel elements or loose plate baskets. A maximum of 42 baskets can be loaded in the NAC LWT MTR fuel package, with a stack of 6 layers of baskets and 7 baskets per layer.

The applicant used the CSAS25 module of the SCALE 4.3 code system for the criticality safety analyses. Section 6.4.14 and Appendix H of the revised SAR provides discussions of the criticality safety evaluations for transportation packages of the OPAL MTR fuel with a maximum U-235 of 23.5 grams per plate and a maximum of 23 plates per element. The maximum U-235 enrichment is 25 wt%. The total U-235 per fuel element used in the model is 540.5 grams. Table H-2 provides detailed specifications of the fuel element and Table H-1 provides the criticality safety evaluation results for these packages. The results show that the packages with 25% U-235 enrichment fuel all have k_{eff} lower than that of the same fuel plates and element design evaluated at a 94 wt% enrichment which has a k_{eff} of 0.92885. The Criticality Safety Index for this package is 0.0.

6.2 Conclusion

The staff reviewed the criticality safety analyses for the NAC-LWT MTR OPAL fuel packages presented in the revised safety analysis report. The staff also performed confirmatory analyses for the most reactive configuration using CSAS6 module of the SCALE 6.1 code system with the continuous energy cross section library. Although the staff’s criticality calculation shows a higher k_{eff} for the package with 540.5 grams of U-235 loading (23 plates x 23.5 grams), k_{eff} = 0.9450+1 0.0021, the actual k_{eff} should be much lower because the U-235 loading is limited to 490 grams of U-235 per element.

Based on the results of its review and analyses, the staff concludes that the applicant has demonstrated with a reasonable assurance that the Model No. NAC-LWT package for MTR OPAL fuel meets the criticality safety requirements of 10 CFR Part 71.

7.0 PACKAGE OPERATIONS EVALUATION

The staff reviewed the package operations, including the proposed changes, to ensure they are appropriate for the proposed changes to the package MTR contents. With the changes to the LEU MTR contents, U-235 mass per plate and mass per element limits described in the package operations needed to be changed. Both limits need to be met and the package operations needed to be clear regarding this point. With the changes to the LEU MTR contents, the applicant also added a new Figure 7.1-13. This figure shows the loading curves for the proposed LEU MTR contents at 10w, 20w, 30w, and 40w. The package operations were modified to account for this new figure and describe how it is used to determine a LEU MTR element's decay acceptability and a method by which its decay heat may be determined. Fuel elements with a burnup and cooling time that are below the 40 watts curve are not acceptable contents and may not be shipped in the LWT package. As noted in Section 5 of this SER, the figures for currently approved contents were modified to include a new minimum cooling time of 90 days. The respective figures in Chapter 7 of the SAR include this modification. Based on its review, the staff finds that the figures and package operations descriptions in Chapter 7 of the SAR are appropriate and adequate for the purposes of ensuring the package is operated in a manner that is consistent with the package analyses in the application.

The staff notes that the scale of the figures used for determining the acceptability of the MTR contents are quite large, which can introduce uncertainties in the process for elements with burnups and cooling times that result in the elements being on or close to the loading curve. The applicant included instructions in the package operations for the user to take into account uncertainties in the use of the curves in determining the acceptability of the elements proposed for shipment. Generally, the staff expects that the applicant will propose a method for a package user that is easy to use and that any uncertainties in that method would be accounted for in the applicant's analysis. Based on information from the applicant to justify this approach, the staff finds that the applicant's current approach to the issue is adequate for this application. This information includes the applicant's performance of compliance reviews prior to each shipment as part of its services to LWT users. The applicant can use the data that generated the curves and so alleviates concerns regarding uncertainties due the figures' scale.

The staff reviewed the Operating Procedures in Chapter 7 of the SAR to verify if the package will be operated in a manner that is consistent with its design evaluation. On the basis of its evaluation, the staff concludes that the combination of the engineered safety features and the operating procedures provide adequate measures and reasonable assurance for safe operation of the proposed MTR fuel in accordance with 10 CFR Part 71.

CONDITIONS

The following changes have been made to the certificate of compliance:

Condition No. 5.(a)(3)(i) was revised to specify the revised drawings for the Body Assembly.

Condition No. 5.(b)(1)(iv)(c) is revised to reflect updated fuel parameters and the bounding case of 490 g maximum U-235 content per element for all MTR fuels listed in the expanded LEU MTR fuel content description table.

Condition No. 5.(b)(2)(iv)(b) was revised to allow decay heat not exceeding 40 watts per element for LEU MTR fuel elements in any basket position.

Condition No. 5.(b)(2)(iv)(f) was revised to reflect updated allowed amounts of 23.5 g ^{235}U per plate (490 g ^{235}U per element) for MTR fuel elements.

Condition No. 12 was revised to delete the use of a personnel barrier for MTR, DIDO fuel assemblies, TRIGA fuel elements, TRIGA fuel cluster rods, high burnup PWR or BWR rods, PWR MOX rods, TPBAR contents, PULSTAR fuel elements, spiral fuel assemblies, MOATA plate bundles, or irradiated hardware.

Condition No. 19 was revised to authorize use of Revision No. 59 of the certificate until the certificate expiration date of February 28, 2015.

The References section was updated to include the supplements dated December 31, 2013, May 30, 2014, and July 15, 2014.

CONCLUSION

Based on the statements and representations in the application, and with the conditions listed above, the staff finds that the proposed 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. 60, on August 8, 2014.