SAFETY EVALUATION REPORT

Docket No. 71-9225
Model No. NAC-LWT
Certificate of Compliance No. 71-9225
Revision 73

SUMMARY

By application dated October 28, 2022 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML22301A183), as supplemented on April 17, 2023, and May 17, 2023 (ADAMS Accession Nos. ML23107A146 and ML23137A340, respectively) NAC International, Inc., (NAC or the applicant) requested a revision to the Certificate of Compliance (CoC or the certificate) No. 9225, for the Model No. NAC-LWT package. NAC requested an amendment to add strontium fluoride (SrF_2) as newly approved contents of the NAC LWT. There are two varieties of the SrF_2 material: Waste Encapsulation and Storage Facility (WESF) capsules and Byproduct Utilization Program (BUP) 500 capsules. The transport of this material requires new basket assemblies and spacers to position the material within the NAC-LWT package.

Following staff review of the associated safety analysis report (SAR), the staff finds that the changes do not affect the ability of the package to meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

EVALUATION

1.0 GENERAL INFORMATION

1.1 Packaging Description

The NAC-LWT is a Type B(U)F-96 radioactive material transportation packaging design. It transports several types of contents, including light-water reactor spent fuel, research reactor spent fuel, and high enriched uranyl nitrate liquid in containers specifically designed for the liquid. The NAC-LWT package may be shipped by truck, boat, or railcar and depending on the content, within an international shipping organization (ISO) container.

1.2 Packaging Drawings

The applicant submitted seven new drawings and revisions to one drawing. The new drawings show the new baskets, lids, lids spacers, and container assemblies associated with the new WESF and BUP-500 capsule contents being requested for the package.

Revised drawing:

LWT 315-40-128, Rev 5	Legal Weight Truck Transport Cask Assy TPBAR Shipment Safety Analysis Report

New drawings:

LWT 315-40-190, Rev 0P	LWT Transport Cask Shipping Configuration, WESF Capsules, Zeno
LWT 315-40-191, Rev 2P	WESF Capsules Basket Assembly, Zeno LWT
LWT 315-40-192, Rev 2P	WESF Capsules Container Assembly, Zeno LWT

LWT 315-40-193, Rev 1P LWT Lid Spacer, WESF Capsules, Zeno
LWT 315-40-195, Rev 1P LWT Transport Cask Shipping Configuration, BUP-500, Zeno
LWT 315-40-196, Rev 2P BUP-500 Basket Assembly, Zeno
LWT 315-40-197, Rev 1P BUP-500 Cavity Spacer, Zeno

1.3 Contents

The applicant requested approval of new contents to be used along with a new basket assembly. The new contents requested in this amendment are SrF_2 capsules, which come in two varieties: WESF capsules and BUP-500 capsules. Parameter limits of the new contents are listed in section 5(b)(1)(xxiii) of the certificate. The table from the certificate is reproduced below:

Table 1-1-1: Parameter Limits for SrF_2 Capsules (Table in CoC Section 5.(b)(1)(xxiii))

Parameter	WESF capsules	BUP 500 capsules
Maximum Cask Heat Load (W)	2400	2200
Maximum per Capsule Heat Load (W)	400	1100
Maximum Activity per Cask (Ci Sr-90)	1.062E+06	3.52E+05
Payload Limit (lb.)	396	300

2.0 STRUCTURAL EVALUATION

The objective of the structural evaluation is to verify that the applicant has adequately evaluated the structural performance of the package (packaging together with contents) and demonstrated that it meets the regulations in 10 CFR Part 71, “Packaging and Transportation of Radioactive Material.”

The staff reviewed and evaluated the proposed changes primarily in SAR section 2.0, revision 22A and updated documents submitted with revision 23A and 23B (ADAMS Accession No. ML23107A146). This section of the safety evaluation report (SER) documents the staff’s reviews, evaluations, and conclusions with respect to structural safety aspects of the amended transport package.

2.1 Description of Structural Design

The applicant requested in this amendment to add SrF_2 fuel material to the list of approved contents. There are two varieties of the SrF_2 material: WESF capsules and BUP-500 capsules. The transport of this material requires two separate basket assemblies and spacers to position the material within the NAC-LWT transport package. As stated in the SAR and shown on submitted drawings, each basket assembly is made up of a pressurized-water reactor (PWR) fuel basket and a new basket insert. The WESF basket assembly contains the container assemblies with WESF fuel capsules and a lid spacer; and the BUP-500 basket assembly contains BUP-500 fuel capsules and spacers. The NAC-LWT transport package and other associated components remain unchanged.

2.2 Structural Evaluation under Normal Conditions of Transport and Hypothetical Accident Conditions

The applicant has analyzed and evaluated the basket assembly components (i.e., PWR fuel basket, basket insert, container assembly, spacers, canister strength members) under Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC). Each component

design was evaluated for side drop and end drop orientations which represent the two limiting cases. The evaluations indicated that both baskets are supported along their lengths in bearing on the inner shell during the side drop, and all structural loads are transmitted to the package structure. The results of the evaluations demonstrated that the basket assembly components do not buckle under the loads in the end drop orientation. The staff reviewed the calculated stresses in the basket assembly components and found that they are bounded by the allowable stresses per ASME Boiler and Pressure Vessel Code, Section III, Division 1, Sub-section NG and Appendix F.

The staff found that the weight of the basket assembly with its contents and spacers for each of the WESF and BUP-500 material is less than 4000 pounds, which was the bounding weight (for the PWR fuel basket assembly with its content) accepted in the previous structural analyses and evaluations, as provided in SAR table 2.2.1-1. Since there is no design change to the basket material and configuration, the previously accepted PWR fuel basket evaluations, as provided in SAR sections 2.6.12.3 and 2.7.7.3, remain bounding for SrF_2 material transport under NCT and HAC. Thus, the staff concludes that both basket component designs support the package contents under NCT and HAC.

NAC-LWT package shipping weight with WESF load and BUP-500 load each is less than the package shipment design weight of 52,000 pounds evaluated previously. Also, the transport package design did not change and therefore its structural performance remains bounding for SrF_2 material transport under NCT and HAC. As a result, the staff concludes that the baskets and the package with new contents will continue to meet the requirements of 10 CFR Part 71.

2.3 Evaluation Findings

Based on the review of the statements and representations in the SAR, the staff concludes that the performance of the NAC-LWT package while carrying SrF_2 material is adequately described and evaluated to demonstrate that the package continues to perform its original safety function and meets the structural integrity requirements of 10 CFR Part 71.

F2-1 The staff has reviewed the package structural design description and concludes that the contents of the application satisfy the requirements of 10 CFR 71.31(a)(1) and (a)(2) as well as 10 CFR 71.33(a) and (b).

F2-2 The staff reviewed the structural performance of the packaging under the normal conditions of transport required by 10 CFR 71.71 and concludes that there will be no substantial reduction in the effectiveness of the packaging that would prevent it from satisfying the requirements of 10 CFR 71.51(a)(1).

F2-3 The staff reviewed the structural performance of the packaging under the hypothetical accident conditions required by 10 CFR 71.73 and concludes that the packaging has adequate structural integrity to satisfy the subcriticality, containment, and shielding requirements of 10 CFR 71.51(a)(2).

3.0 THERMAL EVALUATION

NAC, by way of a letter dated October 28, 2022, has applied to revise the NAC-LWT package CoC No. 9225 to permit the transport of solid strontium salts, specifically SrF_2 in two capsule varieties: WESF capsules and BUP-500 capsules. The transport of these capsules requires new basket inserts (assemblies and spacers) for the existing PWR basket to position the material within the NAC-LWT transport package. A general description of the proposed contents is

provided in SAR section 1.2.3.17 for the NAC-LWT package (Revision 22A), with some specific (basic) characteristics of the two types of capsules being provided in SAR table 1.2-19.

3.1 Description of Thermal Design

According to the applicant, the primary design criteria for heat rejection from the NAC-LWT package are the following: 1) Important to safety (ITS) components "shall not be subjected to temperatures outside their safe operating ranges", and 2) Thermally induced stresses in the LWT package containment components (combined with pressure and various load condition stresses) "shall not cause degradation of the package containment capability".

The applicant provides a description of the thermal design of the new capsule carriers (PWR basket inserts) in SAR section 3.1 which states the following (as summarized below):

- Unique PWR basket inserts have been designed for the loading of SrF_2 capsules.
- In the PWR basket with BUP-500 basket assembly insert, up to two BUP-500 capsules may be transported.
- A total heat load of 2.2 kW, uniformly distributed between two BUP-500 capsules, is allowed for the LWT package.
- Using a PWR basket with WESF insert, up to eighteen WESF capsules may be transported (divided into 6 WESF capsule containers with 3 capsules in each container).
- A total (maximum) heat load of 2.4kW is allowed for the LWT loaded with WESF capsules.
- Any LWT containing SrF_2 capsules will be placed into an ISO container for shipment.

As described in SAR section 3.4.1.22, the thermal analysis involves modeling the package and simulating its contents in an Ansys® finite element analysis (FEA) model which accounts for the LWT package in the horizontal (transport) orientation, and the components of the package (including the contents) are shifted downward to simulate this orientation; however, the applicant states that there is no contact considered in the entire model.

The gaps that are included in the models for the two types of SrF_2 capsules (the contents) are listed by the applicant as follows:

First, for the BUP-500 capsules:

1) a gap between the package liner and basket insert strength member,
2) a gap between the strength member and the PWR basket insert,
3) a gap between the PWR basket insert and the PWR basket, and
4) a gap between PWR basket and the package inner shell.

Then, for the WESF capsules:

1) a gap between the inner and outer capsules,
2) a gap between the outer capsule and the WESF container assembly,
3) a gap between the WESF container assembly and the PWR basket insert,
4) gaps between the PWR basket insert and the PWR basket, and 5) a gap between the PWR basket and the package inner shell.

The staff finds that the applicant's treatment of gaps in their analysis model is conservative.

For the body of the package, as described in SAR section 3.4.1.22, outboard of the outer surface of the PWR basket, the applicant modeled the package components and included specific gaps in the model.

The package components modeled include:

1) the inner shell of the package;
2) the (poured) lead gamma shield,
3) the outer shell of the package,
4) the liquid-filled neutron shield,
5) the liquid neutron shield shell,
6) the liquid shield shell expansion tank, and
7) the outer skin of the expansion tank.

The gaps included in the package model were:

1) a gap between the loaded basket and the inner shell of the package, and
2) a uniform gap between the poured lead shielding and the outer shell of the package.

The gaps described above are depicted in SAR figure 3.4-26.

The three-dimensional thermal model generated by the applicant for the analysis of the SrF_2 capsule contents is depicted as SAR figure 3.4-27.

3.2 Material Properties and Component Specifications

The specifications and thermal properties of NAC-LWT package main components remain unchanged because there is no change in the basic thermal design of the package.

The staff reviewed the proposed changes to CoC, revision 72 (Enclosure 1 to the application) and the list of SAR changes (Enclosure 3) and the proposed revisions to sections 1 and 3 of the application (SAR, Rev. 22A) and verified that the changes proposed to specifications or thermal properties of the main components of the package, in order to add the SrF_2 contents, do not adversely impact thermal performance.

The applicant, in SAR section 3.4.1.22, discusses the thermal evaluation of the SrF_2 capsules (contents) and provides information on the material properties of the BUP-500 and WESF capsules.

For the BUP-500 capsules, the material properties of SrF_2 salt, Haynes-25 (liner material), argon gas, and Hastelloy (strength member) used in the analyses are taken from the DOE document: “Request for DOE Exemption and DOE Certificate of Compliance for the Shipment of a Single, Large Radioisotope Thermoelectric Generator (RTG) for One-Way Transport and Disposal – BUP-500”.

The applicant indicates that there are three types of WESF strontium (Sr) salt capsules with the bounding type being “Type 1” as this capsule presents the largest gap between the capsules and the minimum wall thickness, which results in the highest Sr salt temperature for the contents in the LWT (for this type of capsule).

3.3 Thermal Evaluation under Normal Conditions of Transport (NCT)

Utilizing the analysis models described above, the applicant analyzed the LWT package with the SrF_2 contents for NCT. As described in section 3.4 of the applicant's SAR, the boundary conditions described in 10 CFR 71.71, namely the maximum decay heat load for the contents, a maximum ambient (environmental) temperature of 100 degrees Fahrenheit (°F) (38 degrees Celsius(°C)), with solar insolation on the ISO container surfaces, were applied to the LWT package analysis models for NCT.

The applicant has indicated that the impact limiters on the LWT package are not explicitly modeled for this analysis and, as a consequence, the end regions of package analysis model are not covered by the impact limiters under NCT. This approach is considered conservative. The results of the analyses completed by the applicant for the NCT "hot" case, are provided in SAR table 3.4-29.

The thermal performance of the NAC-LWT package with the newly proposed contents continues to be bounded under NCT by payloads with higher heat loads (specifically PWR fuel assembly content, as presented in SAR table 3.4-2) previously reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) staff; therefore, the package continues to meet the thermal requirements of 10 CFR Part 71 for NCT.

3.4 Thermal Evaluation under Hypothetical Accident Conditions

The applicant used two 180-degree three-dimensional analysis models, as stated in SAR section 3.5.1, to evaluate the effects of HAC on the LWT package with the SrF_2 contents. For the models used, described in detail in SAR section 3.4.1.22, the entire length of the package body is modeled and the air in ISO container is removed from the model, allowing the fire condition to be directly applied to the package surfaces. The applicant further modified the models to add portions of the package body normally covered by impact limiters, in order to allow for a direct exposure of these surfaces to the fire boundary condition. This approach is considered conservative, as the insulating effect of the impact limiters on the ends of the package body are neglected.

As described in SAR section 3.5.1.3, the boundary conditions described in 10 CFR 71.73, namely the pre-fire condition of maximum decay heat load for the contents, a maximum ambient (environmental) temperature of 100°F (38°C), with solar insolation on the ISO container surfaces, were applied to the LWT package model.

The fire exposure was applied to the exterior surfaces of the LWT package for a duration of 30 minutes and were applied as a convection boundary condition with an ambient temperature of 1475°F (800°C) and a 0.9 absorptivity. A film coefficient appropriate for simulating the interior of an open pool fire is multiplied by 1.5 and then applied to the model for the duration of the fire exposure. The neutron shield tank is assumed intact and filled with liquid during the fire exposure; however, following the exposure, the interior of the neutron shield and overflow tank is replaced with air and radiation heat transfer is modeled in the interior of the shield shell and tank. The staff finds that the applicant's approach to application of HAC boundary conditions to their analysis model is conservative.

The results of the analysis for HAC applied to the LWT package with the Sr salt contents is discussed by the applicant in SAR section 3.5.3.20. The applicant states that: "The allowable Sr temperature is associated with the salt interface temperature, not the peak temperature in the salt." This assertion is based on information provided in the report "Thermal Analysis of a Dry

Storage for Capsule Dry Storage Project (WMP-16940, Rev. 0)" which was cited by the applicant, but not provided. Staff located the reference online, reviewed it, and finds that use of the information provided by the reference was appropriate and acceptable.

The applicant reports the temperature history of the salt interface, aluminum basket, and helium gas internal to the package, before, during, and after the fire, in SAR figures 3.5-20 (BUP-500 capsule configuration) and 3.5-21 (WESF capsule configuration). Specific component temperatures from the analyses completed by the applicant for HAC were provided in SAR table 3.5-7.

The applicant indicates that allowable temperatures for the Sr salt interface is 1,472°F (800°C) and for aluminum (basket material) is 500°F (260°C). The temperatures indicated for these components in the analysis provided by the applicant are less than the allowable temperatures cited. The staff finds the assessment provided by the applicant on the Sr salt interface temperatures acceptable.

The thermal performance of the NAC-LWT package with the newly proposed Sr salt contents continues to be bounded under HAC by payloads with higher heat loads previously reviewed and approved by the NRC staff; therefore, the package continues to meet the requirements of 10 CFR 71.73 for HAC.

3.5 Evaluation Findings

Based on the staff's review of the statements and representations in the application, the staff finds that the addition of SrF_2 capsules, in the BUP-500 and WESF configurations, as contents to the NAC-LWT package has been adequately described and evaluated that the staff has reasonable assurance that the thermal performance of the package meets the thermal requirements of 10 CFR Part 71.

F3-1 The staff has reviewed the package description and evaluation and concludes that they satisfy the thermal requirements of 10 CFR Part 71.

F3-2 The staff has reviewed the material properties and component specifications used in the thermal evaluation and concludes that they are sufficient to provide a basis for evaluation of the package against the thermal requirements of 10 CFR Part 71.

F3-3 The staff has reviewed the methods used in the thermal evaluation and concludes that they are described in sufficient detail to permit an independent review, with confirmatory calculations (if needed), of the package thermal design.

4.0 CONTAINMENT EVALUATION

No containment evaluation was necessary as no changes were made to the containment boundary to accommodate the new contents.

5.0 SHIELDING EVALUATION

The staff reviewed the applicant's SAR, calculations, and computer inputs and outputs to ensure that there is adequate protection to the public and occupational workers. The review was performed to verify that the package design meets the external radiation requirements of 10 CFR 71.47 and 10 CFR 71.51 for NCT and HAC under exclusive use of transport.

NUREG-2216, *Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material*, was used to guide the staff's review.

5.1 Description of Shielding Design

Features relied on for shielding in this amendment are the same as those previously reviewed by the NRC except for inserts designed to fit inside the pressurized water reactor fuel basket. The two payload configurations analyzed were two BUP-500 canisters held axially in the center of the package or 18 WESF capsules held in groups of three spaced axially. The geometric configuration of the sources is fixed by the aluminum basket inserts. Only undamaged canisters or capsules will be loaded so the SrF_2 contents are not expected to reconfigure during NCT or HAC. Based on the review given in section 2 of this safety evaluation report the staff finds this approach to maintain the contents configuration during NCT and HAC acceptable.

5.2 Maximum External Radiation Levels

Tables 5-1 and 5-2 show the maximum external does rates for the BUP-500 canisters and WESF capsules respectively. The calculated values for these tables come from tables 5.3.25-6 and 5.3.25-7 of the SAR. The staff finds the calculated maximum dose rates are below regulatory limits for exclusive use shipments and concludes that they are acceptable.

Table 5-1: Maximum external does rates for BUP-500 canisters under normal and accident conditions

Transport Condition	Dose Rate Location	Calculated [mrem/hr]	Limit [mrem/hr]
Normal	Side Surface of Cask	3.7	1000
	1 m from Side of Cask (Transport Index)	0.43	N/A
	2 m from Truck- Radial	0.13	10
	Dose at Cab of Truck	0.0011	2
Accident	1 m from Side of Cask	1.1	1000

Table 5-2: Maximum external does rates for WESF capsules under normal and accident conditions

Transport Condition	Dose Rate Location	Calculated [mrem/hr]	Limit [mrem/hr]
Normal	Side Surface of Cask	8.9	1000
	1 m from Side of Cask (Transport Index)	1.6	N/A
	2 m from Truck- Radial	0.63	10
	Dose at Cab of Truck	0.012	2
Accident	1 m from Side of Cask	3.7	1000

5.3 Source-term Calculation Method

The applicant calculated the radiation source-term using the ORIGEN sequence of SCALE 6.2.4. The applicant decayed two curies (Ci) of Sr-90 by one half-life of 28.79 years to yield one (1) Ci of Sr-90 and its daughter Y-90. The staff finds the use of one Sr-90 half-life to be acceptable because it allows enough time for secular equilibrium to be reached.

The staff also finds the use of a uranium dioxide (UO_2) matrix for the generation of x-rays and gamma rays to be acceptable. Staff calculations confirmed that the fraction of beta particle energy that is transformed into Bremsstrahlung using UO_2 is higher than would occur in SrF_2. Thus, using UO_2 as the source material is more conservative. Differences in self-shielding of beta particles in UO_2 versus SrF_2 are not a concern because of the short range of beta particles in both materials. Both materials block all beta particles so using photons as the primary particle for the shielding calculations is acceptable.

The applicant took the output of photon abundance versus energy from SCALE and multiplied it by the total number of curies of Sr-90 in the BUP-500 canisters and WESF capsules, 176,000 Ci and 59,000 Ci respectively, and input to the shielding model in MCNP. The staff found this acceptable but unnecessary because MCNP normalizes the energy distribution. The applicant corrected the inventory for each payload using the tally multiplier.

The staff finds the use of an approximately 10 percent factor to account for uncertainty in the capsule contents to be acceptable. The factor used is of low risk significance because the maximum external dose rates are low when compared to the regulatory limits.

5.4 Shielding Model and Model Specifications

The applicant provided assumptions used in the calculation package 50066-5001, Rev. 0 (SAR enclosure 2). Assumption one states that the HAC model does not include the neutron shielding material or impact limiters. Assumption three states that under NCT the impact limiter radius is modeled with the same dimensions as the neutron shield tank. The staff finds the removal of material in both models to be appropriately conservative.

Assumption two states that the same lead gap size is used to analyze the NCT and HAC and that lead slump does not need to be accounted for. The applicant justifies this assumption by stating that during manufacture the lead is poured in stages to eliminate any gaps. The staff reviewed drawing, LWT 315-40-03, Rev. 22 (ADAMS accession no. ML080220137), to confirm that no lead gap is present in the manufactured package. The staff finds that lead slump does not need to be analyzed under HAC because no lead gap is present. The staff finds the inclusion of the 0.1374 cm lead gap under NCT and HAC to be conservative.

Material properties used in the MCNP model are in tables 4-1, 4-3, 4-6, and 4-7 of calculation package 50066-5001, Rev. 0.

Dimensions used in the MCNP model are in tables 5.3.25-3 and 5.3.25-4 of the SAR and are found to match those in the drawings.

5.5 Shielding Evaluation Method

The applicant calculated the external flux rate using MCNP run with the default cross section library. The applicant converted the flux rate to dose rate using the American National Standards Institute/American Nuclear Society (ANSI/ANS)-6.1.1-1977 flux to dose rate conversion factors. The staff finds that these methods which are recommended in NUREG-2216 were appropriate.

5.6 Confirmatory Analysis

The staff confirmed the applicant's analysis by verifying the provided inputs and outputs to SCALE and MCNP for the BUP-500 canister under HAC. The staff confirmed that the input to

SCALE was correctly created and run. The staff then confirmed that the applicant correctly took the photon abundance data from the SCALE output and prepared it for use in MCNP.

The staff then checked the MCNP inputs for the dimensions and materials for accurate transcription from the SAR and calculation package. Finally, the staff checked the MCNP outputs to confirm convergence and that dose rates were appropriately transferred to the SAR. The staff finds that the computer analysis was performed appropriately.

5.7 Evaluation Findings

The staff finds, based on its review, that for the NAC-LWT loaded with the BUP-500 canisters or WESF capsules and basket inserts, dose rates will meet the requirements of 10 CFR 71.47 and 10 CFR 71.51 for an exclusive use shipment.

F5-1 The staff has reviewed the application and finds that it adequately describes the package contents, and the package design features that affect shielding in compliance with 10 CFR 71.31(a)(1), 71.33(a), and 71.33(b), and provides an evaluation of the package's shielding performance in compliance with 10 CFR 71.31(a)(2), 71.31(b), 71.35(a), and 71.41(a). The descriptions of the packaging and the contents are adequate to allow for evaluation of the package's shielding performance. The evaluation is appropriate and bounding for the packaging and the package contents as described in the application.

F5-2 The staff has reviewed the application and finds that it demonstrates the package has been designed so that under the evaluations specified in 10 CFR 71.71 (normal conditions of transport), and in compliance with 10 CFR 71.43(f) and 10 CFR 71.51(a)(1), the external radiation levels do not significantly increase.

F5-3 The staff has reviewed the application and finds that it demonstrates that under the evaluations specified in 10 CFR 71.71 (normal conditions of transport), external radiation levels do not exceed the limits in 10 CFR 71.47(b) for exclusive-use shipments.

F5-4 The staff has reviewed the application and finds that it demonstrates that under the tests specified in 10 CFR 71.73, external radiation levels do not exceed the limits in 10 CFR 71.51(a)(2).

F5-5 The staff has reviewed the application and finds that it identifies codes and standards used in the package's shielding design and in the shielding analyses, in compliance with 10 CFR 71.31(c).

F5-6 The staff has reviewed the application and finds that it includes operations descriptions, acceptance tests, and maintenance programs that will ensure that the package is fabricated, operated, and maintained in a manner consistent with the applicable shielding requirements of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

An update to the criticality evaluation was not needed for this license amendment request. Sr-90 is not fissile, and no changes were made to the other fissile contents of the package.

7.0 MATERIALS EVALUATION

The staff reviewed Revision 73 to the NAC-LWT SAR to verify that the material performance of the WESF and BUP-500 Basket Assemblies meet the requirements of 10 CFR Part 71. The WESF basket assembly is designed to position and support up to 18 WESF capsules. The BUP-500 basket assembly is designed to position and support up to 2 BUP-500 capsules.

7.1 Materials of Construction

As described in Calculation Package 50066-2001, Calculation Package 50066-2002, and the licensing drawings, the WESF Basket assembly is comprised of the existing NAC-LWT PWR fuel basket, a new WESF PWR Basket Insert, and six WESF container assemblies. The WESF PWR Basket Insert is fabricated of an ASTM 6061 series plate/bar/forge/casting. The six WESF Container Assemblies are comprised of aluminum alloy bodies and bottoms fabricated of an ASTM 6061 series plate/bar/forge/casting and a tie rod fabricated of 304 stainless steel (ASTM A276). The Lid Spacer is comprised of a baseplate, space tube, end plate, and four ribs fabricated of 304 stainless steel.

As described in Calculation Package 50066-2001, Calculation Package 50066-2002, and the licensing drawings, the BUP-500 Basket assembly is comprised of the existing NAC-LWT PWR fuel basket, a new BUP-500 PWR Basket Insert, and three Cavity Spacers. The BUP-500 PWR Basket Insert is fabricated of an ASTM 6061 series plate/bar/forge/casting. The three Cavity Spacers are comprised of an aluminum alloy tube fabricated of 6061 T6 and two aluminum alloy endplates fabricated of 6062 T651.

Per the above discussion, the staff finds that the applicant's description of the materials of construction to be acceptable.

7.2 Drawings

The applicant provided new drawings in SAR Volume 1 to incorporate the new WESF Basket Assembly, Container Assembly, and Lid Spacer and the new BUP-500 Basket Assembly and Cavity Spacer. The drawings include a parts list that provides the material specification of each component, and they also provide the welding and examination requirements. The staff notes that the level of detail in the new drawings are consistent with those of the previously approved drawings. The staff reviewed the drawing content with respect to the guidance in NUREG-2216 Section 7.4.1 "Drawings" and NUREG/CR-5502, "Engineering Drawings for 10 CFR Part 71 Package Approvals." The staff confirmed that the drawings provide an adequate description of the materials, fabrication, and examination requirements. Therefore, the staff finds the drawings to be acceptable.

7.3 Codes and Standards

The staff verified that the new WESF and BUP-500 Basket Assemblies use ASTM International steel materials and aluminum alloys. The staff notes that the cited material standards are consistent with the NRC guidance in NUREG-2216, which states that important to safety components that do not comprise the containment boundary may be constructed of materials the ASME, ASTM, or the American Iron and Steel Institute certified.

The staff verified that the new WESF and BUP-500 Basket Assemblies follow the same structural and allowable stress criteria used for containment structures and bolting materials as the previously approved fuel baskets, ASME B&PV Code Section III, Subsection NG. The staff

notes that the cited standards are consistent with the NRC guidance in NUREG-2216, which states that fuel basket structures may be fabricated in accordance with ASME B&PV Code Section III, Subsection NG, “Core Supports”.

Therefore, the staff finds the materials codes and standards to be acceptable.

7.4 Welding

The new WESF and BUP-500 Basket Assemblies use the same welding codes and standards as the previously approved designs. The weld design and nondestructive examination (NDE) will be in accordance with ASME B&PV Code Subsection NG, and the welding procedures, processes, and welder qualifications will be in accordance with ASME B&PV Code Section IX. The visual examinations of the welds will be performed in accordance with ASME Code, Section V, Articles 1 and 9, with acceptance standards per Section III, Subsection NG, Article NG-5360. The staff reviewed ASME codes for the design, fabrication, and examination of the welds in the application. The staff determined that the ASME codes identified are consistent with the guidance in NUREG-2216. Therefore, the staff finds the welding and NDE codes and standards to be acceptable.

7.5 Material Properties

As described in the Design Input Section of Calculation Package 50066-2002, the applicant did not make any changes to the mechanical properties and thermal properties used in the structural analyses and thermal analysis, except for the material defined as aluminum or aluminum alloy with yield strength, ultimate strength, and thermal conductivity greater than or equal to 6061 Series. These material property values, as stated by the applicant, are conservatively chosen to be that of 1100-0 Aluminum. The staff reviewed these properties by comparison to other similar ASTM 1100-0 property values. While the staff finds the values provided for yield strength and ultimate strength to be higher than expected for Aluminum 1100-0, the staff agrees theses values are conversative and bounding for the 6061 Series Aluminum under the service conditions of the package.

The staff reviewed the applicant’s thermal analysis to ensure that the material properties remain valid under the service conditions associated with the WESF and BUP-500 Capsules loaded into the NAC-LWT package. In Calculation Package 50066-3001, the applicant evaluated the maximum temperatures of the WESF and BUP-500 fuel, WESF and BUP-500 fuel baskets, and the LTW package under normal and accident conditions. The staff reviewed the applicant’s analysis and verified that the component temperatures remain below each of the material’s allowable service temperatures. Therefore, the staff finds the mechanical and thermal properties used in the applicant’s structural and thermal analysis to be acceptable.

7.6 Bolt Applications

As described in the Design Input Section of Calculation Package 50066-2002, the new WESF Lid Spacer is attached to the LWT lid using four hex head bolts. The staff verified that the new WESF basket assembly uses the same bolting material as the previously NAC-LWT package (ASTM A193 Grade B8 stainless-steel). Therefore, the staff finds the applicant’s bolting materials to be acceptable.

7.7 Corrosion Resistance and Content Reactions

The staff reviewed the revision changes and verified that they do not introduce any adverse corrosive or other reactions that were not previously considered in the staff's prior review of the NAC-LWT CoC. The materials of construction and the service environments are bounded by those that were previously evaluated in the CoC. Therefore, the staff finds the applicant's evaluation of corrosion resistance and potential adverse reactions to be acceptable.

7.8 Package Contents

As described in SAR sections 1.1 and 1.2.3.17, the new WESF Basket Assembly may hold up to eighteen WESF capsules and the BUP-500 Assembly may hold up to two BUP-500 capsules.

The WSEF capsules, as shown in SAR figure 1.2.3-23, consist of a Sr-90 byproduct material sealed inside an inner capsule of C-276 Hastelloy and an outer capsule of 316L stainless steel, with an air gap in between these inner and outer capsules.

The BUP-500 capsules, as shown in figure 1.2.3-34, consist of salt (SrF_2) contained in a Haynes-25 liner, which is inside a C-276 Hastelloy strength member, strength member bottom plate, and lid. The gas in the capsule is argon.

Therefore, the staff finds the description of the package contents to be acceptable.

7.9 Evaluation Findings

F7.1 The applicant has met the requirements in 10 CFR 71.33. The applicant described the materials used in the transportation package in sufficient detail to support the staff's evaluation.

F7.2 The applicant has met the requirements of 10 CFR 71.31(c). The applicant identified the applicable codes and standards for the design, fabrication, testing, and maintenance of the package and, in the absence of codes and standards, has adequately described controls for material qualification and fabrication.

F7.3 The applicant has met the requirements in 10 CFR 71.43(f) and 10 CFR 71.51(a). The applicant demonstrated effective materials performance of packaging components under NCT and HAC.

F7.4 The applicant has met the requirements of 10 CFR 71.43(f) and 71.51(a). The applicant has demonstrated that the package will be designed and constructed such that the analyzed geometric form of its contents will not be substantially altered and there will be no loss or dispersal of the contents under the tests for normal conditions of transport.

The staff concludes that Revision 73 to the NAC-LWT CoC adequately considers material properties and material quality controls such that the design is in compliance with 10 CFR Part 71. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

8.0 PACKAGE OPERATIONS EVALUATION

The purpose of the package operations evaluation is to verify that the proposed changes to the operating controls and procedures of the transport package continue to meet the requirements of 10 CFR Part 71.

The SAR chapter 7 provides procedures for package loading, unloading, and preparation of the empty package for transport. SAR sections 7.1.20 and 7.1.21 provide revised operating procedures for the dry loading of WESF capsules and BUP-500 capsules, respectively, into the NAC-LWT package.

8.1 Evaluation Findings

The staff reviewed the Operating Procedures in SAR chapter 7 to verify that the package will be operated in a manner that is consistent with its design evaluation. Based on 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 dry loading of WESF and BUP-500 capsules in accordance with 10 CFR Part 71. Further, the CoC is conditioned such that the package must be prepared for shipment and operated in accordance with the Operating Procedures specified in the SAR chapter 7.

F8-1 The NRC staff has reviewed the description of the operating procedures and finds that the package will be prepared, loaded, transported, received, and unloaded in a manner consistent with its design and evaluation for approval.

CONDITIONS

In addition to small editorial changes, the following changes have been made to the certificate:

Condition No. 5(a)(3)(ii), “Drawings,” was updated to include the seven new drawings associated with this amendment and the updated to reflect the latest revision of drawing No. LWT 315-40-175, (Sheets 1 - 2), “Caddy Assembly, NRU/NRX.”

Condition No. 5(b)(1)(xxiii), has been added to specify parameter limits on the new contents.

Condition No. 5(b)(2)(xxiv), has been edited to specify that the caddy plug shown in drawing No. LWT 315-40-175 is not required for NRU/NRX fuel shipments.

Condition No. 5(c), has been edited to include the CSI for the new contents.

Condition No. 20, has been edited to specify the termination date of the previous revision of the certificate (revision 72).

The references section has been updated to include this application supplement.

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. 73.