February 22, 2010

Mr. B. K. Miles
Division of Naval Reactors
U.S. Department of Energy
Washington, DC 20585

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9793 FOR THE MODEL NO. M-140 PACKAGE

Dear Mr. Miles:

As requested by your application dated August 5, 2009, enclosed is Certificate of Compliance No. 9793, Revision No. 13, for the M-140 package. This certificate supersedes, in its entirety, Certificate of Compliance No. 9793, Revision No. 12. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's Safety Evaluation Report is also enclosed.

The U.S. Department of Energy is the certificate holder for this package. 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.

If you have any questions regarding this certificate, please contact me or Chris Staab of my staff at (301) 492-3321.

Sincerely,

/RA/

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

Docket No. 71-9793
TAC No. L24363

Enclosures:
1. Certificate of Compliance No. 9793, Rev. No. 13
2. Safety Evaluation Report

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

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OFC	SFST		SFST		SFST		SFST		SFST		SFST	
NAME	CStaab		CBajwa		DForsyth		JPiotter		CCook		MWaters	
DATE	1/19/10		2/5/10		1/19/10		1/25/10		1/25/10		2/4/10	
OFC	SFST		SFST		SFST		SFST		SFST			
NAME	LCampbell		MDeBose		EBenner/JGoshen							
DATE	1/19/10		1/20/10		02/22/2010							

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SAFETY EVALUATION REPORT

Docket No. 71-9793

Model No. M-140 Package

Certificate of Compliance No. 9793

Revision No. 13

SUMMARY

By application dated August 5, 2009, the U.S. Department of Energy (DOE), Naval Reactors (NR) submitted an amendment request for Certificate of Compliance (CoC) No. 9793 for the Model No. M-140 package. The applicant reduced the required hold time of the contents, in terms of days after shutdown (DAS) to facilitate expedited shipment of the contents. The applicant removed some of the conservatism that was present in the initial thermal analysis for this package to maintain critical component temperatures within limits given the shortened cooling time and removed some conservatism to maintain total estimated dose rates with the shortened cooling time. An evaluation of the top spring plate was deleted to be consistent with a bounding analysis contained in the M-140 core-independent Safety Analysis Report for Packaging (SARP). Minor changes were made to the certificate for consistency with the regulations.

1.0 GENERAL INFORMATION

1.1 Packaging

The M-140 is a stainless steel cask for transporting spent fuel. The overall cask dimensions are 98 inches in diameter and 194 inches high. The cask body is 14 inches thick with a closure head that is secured by 36 wedge assemblies located radially around the inside diameter. Penetrations in the closure head and cask body include an access port for fuel loading, vent and drain ports, water inlet and outlet penetrations, and a thermocouple penetration. The cask closure head and penetrations are sealed with plugs and double ethylene propylene O-ring seals. A stainless steel protective dome is positioned over the closure head. The cask body has 180 external vertical cooling fins, and a support ring is welded to these cooling fins. The support ring is bolted to a rail car mounting ring during transport. The fuel is positioned within an internals assembly. The internals assembly is composed of stacked spacer plates that have openings for the spent fuel modules. The maximum weight of the package, including contents, is 375,000 pounds. The applicant reduced the required hold time of the contents, deleted an evaluation of a top spring plate, provided a reanalysis of the internal energy absorbing plate, and made minor changes to the certificate for consistency with the regulations.

The changes made to the General Information section were adequate and in conformance with 10 CFR Part 71.

2.0 STRUCTURAL

The applicant provided two minor changes to the SARP that have minimal safety significance. The first change was the deletion of an evaluation of the top spring plate to be consistent with the bounding analysis in the core-independent SARP. The second change was a reevaluation

of structural performance of an energy absorbing plate whose function is to transmit a uniform load to internal impact absorbing material. The top spring plate was reevaluated in the Core Independent SARP which subsequently demonstrated that the Core Independent analysis was a bounding analysis making the Core-Dependent analysis unnecessary. The top energy absorbing plate was reanalyzed due to the use of incorrect material properties in the original analysis provided by the applicant. In this new evaluation, the applicant demonstrated that the energy absorbing plate was sufficiently stiff to transfer a uniform loading to the internal impact absorbing material consistent with observations made during testing. Staff reviewed the statements and calculations provided by the applicant and has determined that the changes made to the Structural evaluation were sufficient to make a safety finding and in conformance with 10 CFR Part 71.

3.0 THERMAL

The applicant requested an amendment to the certificate for the M-140 package. The major changes related to the thermal evaluation were to reduce the required hold time of the contents, in terms of days after shutdown to facilitate expedited shipment of the contents. The applicant removed some of the conservatism that was present in the initial thermal analysis for this package to maintain critical component temperatures within limits given the shortened cooling time.

3.1 Decay Heat

Estimation of the allowable DAS for shipment is determined by calculating the decay heat for contents and is completed on a case by case basis that takes into account the actual power history of the core. The applicant's evaluation used a best estimate power history and worst case peaking factors to demonstrate how, using a qualified computer code, shipment times and decay heat rates for contents can be determined. The applicant provides a decay heat limit that must be reached before shipment can take place.

The applicant used a conservative model to determine what the allowable decay heat limit would be for three types of contents, claiming that the values derived would be bounding for actual shipments.

3.2 Normal Conditions of Transport

The applicant's analysis, which included two different three dimensional analysis models, applied the normal conditions of transport described in 10 CFR § 71.71 to the package and contents. The analysis demonstrated that component temperature limits were met for the limiting decay heat for the specified contents. Package accessible surface temperatures for transport were determined, and the limits for exclusive use shipments in 10 CFR § 71.43 were met.

3.3 Hypothetical Accident Conditions

The thermal evaluation for hypothetical accident condition (HAC) considered the results of a 30-foot free drop, puncture, and fire tests. The model assumed that structural damage from the drop and puncture tests was minimal, and therefore, the same thermal models used for the NCT analyses were essentially used for the HAC analyses. The applicant analyzed a fire exposure of 1475°F for 30 minutes, in accordance with 10 CFR § 71.73. The temperature limits prescribed by the applicant are for the performance of the contents, and these limits were not

exceeded for the HAC fire exposure.

3.4 Conclusions

The staff reviewed the assumptions and methods made by the applicant regarding the thermal performance of the M-140 package. The staff also reviewed the material properties and analysis modeling approach for both NCT and HAC evaluations. Based on its review of the methods, analyses, and information presented in the application, the staff agrees with the applicant's conclusion that the thermal requirements of 10 CFR Part 71 will be met with the proposed contents and packaging design.

4.0 CONTAINMENT

The containment chapter was revised to reference the bounding containment evaluation contained in the M-140 core-independent SARP. The changes made to the containment section were adequate and in conformance with 10 CFR Part 71.

5.0 SHIELDING

The applicant requested an amendment to the certificate for the M-140 package. The major changes related to the shielding evaluation were to reduce the required hold time of the contents. The applicant intends to remove some of the unnecessary conservatism added in the initial analysis to maintain total estimated dose rates with the shortened cooling time.

5.1 Source Term

The method for estimating the radioactive source term is not necessarily bounding, but assumes the least favorable irradiation history, core location and burnup. All assemblies are then assumed to have identical source strength. The source term is calculated using updated software similar to ORIGEN. The updated calculation also uses a finer gamma energy group structure. The final gamma source term accounts for activation energy, neutron absorption within the fuel, and direct decay sources.

Neutron radiation is assumed to have the same spectrum as spontaneous fission of Cm-244. The neutron source term is explicitly calculated using the parameters of the most depleted region of fuel and scaled based on the least favorable axial distribution.

5.2 Normal Conditions of Transport

The applicant's analysis showed that the radiation limits for the normal conditions of transport in 10 CFR Part 71 are met following a decay time of 150 days after reactor shutdown. Gamma radiation level calculations were made using a point-kernel computer code, while neutron radiation levels were calculated using a two-dimensional transport code.

The expected radiation levels are based on and update to a prior 180-day post shutdown calculation. The new calculation for 150 days used a finer gamma group structure. Both results were summed over the energy groups and compared. A conservative ratio was derived from this and applied to scale the previously calculated dose rates to the shorter cooling time.

5.3 Hypothetical Accident Conditions

The shielding evaluation for the hypothetical accident conditions considered the results of a 30-foot free drop, puncture, and fire tests. The model considered damage and loss of shielding effectiveness. The analyses conservatively assume a uniform reduction in shield thickness equal to both the crush and puncture depth. The movement of the fuel within the cask due to a top or bottom drop is conservatively exaggerated from the expected displacement and taken into account. The internal cavity was assumed to be flooded and the source term was changed to reflect the resulting increase in subcritical multiplication.

5.4 Conclusions

Using the source term specified and the shielding material, staff confirmed that the stated dose rates are indeed conservative. The dose rates calculated by the applicant were within the limits specified in 10 CFR 71.47 and 10 CFR 71.51. Based on its review of the methods, analyses, and information presented in the application, staff agrees with the applicant's conclusion that the shielding requirements of 10 CFR Part 71 will be met with the proposed contents and packaging design.

6.0 CRITICALITY

The applicant requested an amendment to the certificate for the M-140 package. The major change related to the criticality evaluation was to reduce the criticality safety index (CSI) to zero for D2W fuel. The applicant supplied a description of the analysis to support this change.

6.1 Package Loading

The package is designed to contain irradiated spent fuel assemblies. The assemblies will be shipped with control components (CCs) in place. A fresh fuel material composition was used throughout the criticality analysis, and the most reactive fuel type was selected with the CC of least worth. In all cases the outer cask boundary was reflective, resulting in a calculation of k_∞. The value of k_{eff} will always be smaller under any conditions.

6.2 Normal Conditions of Transport

The applicant's analysis showed the requirement that the package will remain subcritical for the normal conditions of transport in 10 CFR Part 71 is met. Normal conditions of transport assume an un-flooded condition. The applicant added water to the cask in trace quantities as an additional conservatism. Conservative adjustments are made for the manufacturing uncertainty maximizing the possible fuel load and minimizing the poison mass. Changes in the value of k due to reactivity increase from beginning-of-life to the point of most reactivity and any uncertainty from manufacturing tolerances are not analyzed. Given the large subcritical margin, these uncertainties are too small to be of concern.

6.3 Hypothetical Accident Conditions

A hypothetical accident condition assumes an optimally flooded cask. In this case, the applicant showed that a preferentially flooded cask is more reactive than a fully flooded case. The fuel assemblies are flooded with full density water, and the surrounding space is partially voided. This provides some moderation while reducing the shielding effect of the moderator. There is no credible scenario that would lead to this situation. Conservative adjustments are made for the manufacturing uncertainty maximizing the possible fuel load and minimizing poison mass. A correction factor was applied to account for the most reactive state of the assembly during the

fuel cycle.

6.4 Assessment

The applicant analysis utilized a Monte Carlo method to solve generalized neutron transport problems. The hydrogen thermal scattering matrix was taken from the ENDF/A data, and the nuclear cross sections were from ENDF/B data. In cases where a neutron absorber was modeled dispersed in a material, a conservative correction was applied to account for potential self shielding effects that would reduce the efficacy of the poison.

The applicant provided a list of applicable benchmarks to determine bias and uncertainty of the software used. Benchmark problems were chosen due to similarities with fissile and structural materials present, and fissile solution benchmarks were included to verify analyses of flooded conditions.

Staff conducted confirmatory analyses with the KENO-VI module in SCALE. Due to the sensitive nature of the contents, limited material and geometric information is specified. Staff analysis used estimated material properties and homogenized fuel zones with discretely modeled CCs of approximate dimensions. Since the staff was not able to reproduce the model and verify the actual value for k_{eff}, confirmatory analysis focused on verifying the conservative adjustments made by the applicant. However, staff criticality estimates were in reasonable agreement with those of the applicant. Based on its review of the methods and calculations to confirm that approximations and analyses are indeed conservative, staff agrees with the applicant's conclusion that an infinite array of packages meets the criticality requirements of 10 CFR Part 71.55 and the CSI index is zero for D2W fuel.

7.0 PACKAGE OPERATIONS AND ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

No changes were proposed to the operating procedures or acceptance and maintenance testing. Operating procedures such as procedures for loading the package, procedures to unload the package, and preparation of an empty package for transport remain adequate and conform to the requirements of 10 CFR Part 71. Acceptance and maintenance testing such as visual inspection, material testing, structural and pressure testing, leak testing, and component testing remain adequate and conform to the requirements of 10 CFR Part 71.

CONDITIONS

The following conditions in CoC No. 9793, have been revised as follows:

Condition 5(a)(2) was revised to state the support ring is bolted to a specially designed well-type railcar.

Condition 5(b)(2) was revised to increase allowable total core decay heats for D2W fuel based on reducing the minimum fuel cooling time.

Condition 9 was revised to reduce the minimum fuel cooling time for D2W fuel to 150 days.

Condition 5(c) was revised to change the CSI for D2W fuel to 0.

Condition 18 was revised to state the previous revision of the CoC may be used until February 28, 2011.

Condition 19 was added to state transport by air of fissile material is not authorized.

CONCLUSION

As requested by the application, dated August 5, 2009, CoC No. 9793 for the M-140 package has been amended with conditions allowing a reduced cooling time for D2W fuel.

Based on the staff's review, the statements and representations in the application and for the reasons stated in this SER, and with the conditions listed above, staff concludes that these changes will not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9793, Revision No. 13,
on February 22, 2010.