SAFETY EVALUATION REPORT

Docket No. 71-9233
Model No. TN-RAM Package
Certificate of Compliance No. 9233
Revision No. 17

SUMMARY

By application dated December 4, 2018, as supplemented January 23, 2019, TN Americas LLC requested an amendment to Certificate of Compliance (CoC) No. 9233, for the Model No. TN-RAM package. The applicant requested to modify impact limiter design parameters for the Model No. TN-RAM package. For this amendment request, staff reviewed Chapters 1 and 2 of the application using the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material" and associated Interim Staff Guidance. Staff reviewed these changes and conclude that they do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

EVALUATION

1.0 GENERAL INFORMATION

The applicant modified the Model No. TN-RAM package design to allow the use of either Nylon 6 or Nylon 6,6 in lieu of Rilsan BMN G8 in the fabrication of a fusible plug designed to prevent over pressurization of the impact limiters under hypothetical accident fire conditions. The applicant also modified the allowable moisture content of the wood used to fabricate the impact limiters. The applicant incorporated these changes into Drawing 990-708. Based on a review of the statements and representations in the application, staff concludes that the package has been adequately described to meet the requirements of 10 CFR Part 71.

2.0 STRUCTURAL EVALUATION

The objective of the structural review is to confirm that the structural performance of the package meets the requirements of 10 CFR Part 71 including the tests and conditions for normal conditions of transport and hypothetical accident conditions.

2.1 Materials Review

TN Americas LLC application for revision to Certificate of Compliance (CoC) No. 9233 for the Model No. TN-RAM included 2 changes for materials.

1. Change Item 19 on SAR drawing 990-708, "FUSIBLE PLUG," to allow the use of an alternative material, Nylon 6 or Nylon 6,6, in lieu of Rislan BMN G8, for the impact limiter's fusible plugs.

2. Revise the allowable moisture content for the wood used in the impact limiter. The compressive strength values for Redwood and Balsa wood impact limiter materials are applicable to the same specified values for the density, but with moisture content revised to range from 6% to 12%, and the temperature range of −20 °F to 165 °F (−29 °C to 74 °C).

The applicant stated that the change in materials of the fusible plug was requested because obtaining Rislan BMN G8 material to fabricate the fusible plugs takes longer and is more expensive. The applicant stated that nylon bolts are readily available at a reasonable price from a wide variety of suppliers.

The applicant stated that the change in the allowable moisture content for both Redwood and Balsa wood is consistent with the range of moisture expected for conditioned wood. The applicant also stated that the revised minimum and maximum moisture contents to 6% to 10% are consistent with the moisture content range specified for MP197HB and TN-LC impact limiter wood that has similar ranges specified for compressive strength.

2.1.1 Impact Limiter Fusible Plug

The applicant stated that the purpose of the fusible plug is to melt during a fire event to prevent pressure build-up within the impact limiter shell. In order to be effective, the applicant stated that the fusible plug is required to have a melting temperature below approximately 300°C (572 °F). The applicant stated that the melting temperature of Rislan BMN G8 material is approximately 186°C (367 °F). The applicant stated that the most common nylon types are Nylon 6 (PA6) and Nylon 6,6 (PA66). The applicant stated that the melting temperatures for Nylon 6 and Nylon 6,6 are in the 210 to 270 °C (410 to 518 °F) range, which is slightly higher than Rislan, but still low enough by a large margin to fulfill the design intent. Based on this comparison, the applicant stated that changing the fusible plug for the impact limiter from Rilsan BMN G8 to Nylon 6 or Nylon 6,6 will not alter the required performance characteristics of the impact limiter fusible plug.

The NRC staff reviewed the mechanical properties and melting temperatures of Rilsan BMN G8, Nylon 6 and Nylon 6,6 and confirmed the applicant's assessment of the melting points of these materials. The NRC staff verified that for unreinforced grades, the mechanical properties and thermal expansion coefficients are also similar and Nylon 6 and Nylon 6,6 have similar maximum continuous use temperatures compared to Rilsan BMN G8. The staff confirmed that the maximum continuous use temperatures for Nylon 6 and Nylon 6,6 are above 93 °C (200 °F) which exceeds the maximum temperature for any accessible surface of a package required in 10 CFR 71.43(g). Based on a comparison of the relevant properties, the NRC staff determined that the applicant's proposed change for the material for the fusible plug from Rilsan BMN G8 to Nylon 6 or Nylon 6,6 is acceptable.

2.1.2 Moisture content and Compressive Strength of Wood for Impact Limiters

The applicant stated that the range of both Redwood and Balsa wood compressive strengths were specified over a temperature range of −20 to 165 °F (−29 to 74 °C) and moisture contents ranging from 6% to 12%. The applicant stated that the range of moisture contents was typical for kiln dried wood. The applicant provided references to support the range of compressive strengths of 5000 to 6500 psi (34.47 to 44.82 MPa) for Redwood and 1560 to 2010 psi (10.75 to 13.86 MPa) for Balsa wood.

The NRC staff reviewed the information on moisture content and compressive strength of wood products. Information available from the Forest Products Laboratory (2010) indicates that a moisture content of 12 percent is typical of most wood for most of the U.S. In dryer climates, the moisture content can be less (typically 6 to 9 percent), and in the Pacific Northwest the moisture content can be up to 16 percent. The NRC staff concluded that the range of moisture content cited by the applicant is typical of most of the U.S.

The NRC staff reviewed the available information on the effect of moisture content and temperature on mechanical properties of wood. Information reported by Gerhards (1982) indicates that compressive strength parallel-to-the-grain increases 35% when the moisture content is decreased from 12% to 6%. For Redwood, testing conducted at Sandia National Laboratories (Cramer et al. 1996; Hill and Joseph, 1974) showed that compressive strength was a function of moisture content and grain orientation. Values reported by Cramer et al. (1996) generally agree with the range of compressive strengths cited by the applicant for Redwood over the range of moisture contents from 6 to 12%. The NRC staff determined that the applicants specified values of compressive strength for Redwood ranging from 6500 psi at −20 °F to 5000 psi at 165 °F are appropriate because they are in agreement with average values reported by Hill and Joseph (1974).

For Balsa wood, the staff reviewed the available information reported by Knoell (1966) which showed that Balsa wood with a density of 10 lb/ft^3 had a mean compressive strength generally above 1500 psi for moisture contents ranging from 0 to 10 percent. At a higher moisture content of 15%, the mean compressive strength decreased to approximately 1300 psi. Knoell (1966) reported the mean compressive strength as a function of temperature in the range of −20 to 165 °F. For Balsa wood with a moisture content of 0%, the mean compressive strength ranges from 2000 psi at −20 °F to 1500 psi at 165 °F. The NRC staff determined that the values of compressive strength for Balsa wood cited by the applicant are appropriate and because they are in agreement with reported values over the range of moisture content values and temperatures.

2.2 Structural Review

The applicant noted in Appendix 2.10.2, “Structural Analysis of Impact Limiters,” that effects of wood properties and initial cask drop angle were considered in numerous computer analysis runs to determine the forces and decelerations used in the cask body structural analysis. Appendix Section 2.10.2.3 stated that the Balsa wood and Redwood densities have been selected to limit the maximum cask body inertia loads due to the one foot normal condition drop and the thirty foot hypothetical accident drop. In the Materials Review above, the NRC staff determined that the compressive strength values for Redwood and Balsa wood materials are applicable to the same specified values for the density when the wood moisture contents are revised to range from 6% to 12%. Because the proposed changes resulted in no impact limiter design changes, including the Redwood and Balsa wood compressive strengths, the staff concludes that the forces and decelerations used previously for package approval continue to apply. This demonstrates that the revised wood moisture contents will not reduce the effectiveness of the TN-RAM cask in meeting the 10 CFR part 71 requirements.

2.4 Findings

Based on a review of the statements and representations in the application, the NRC staff concludes that the TN-RAM package with the proposed changes will perform its intended functions and maintain structural integrity to meet the requirements of 10 CFR Part 71. Based on review of the statements and representations in the application, the staff concludes that the package design has been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

References
1. Cramer, S.M., J.C. Hermanson, W.M. McMurtry, "Characterizing Large Strain Crush Response of Redwood," Sandia Report SAND96-2966/UC-820, December 1996.
2. Forest Products Laboratory, "Wood Handbook Wood as an Engineering Material," Centennial Edition United States Department of Agriculture Forest Service Madison, Wisconsin, April 2010.
3. Gerhards, C.C., "Effect of Moisture Content and Temperature on the Mechanical Properties of Wood: An Analysis of Immediate Effects," Wood and Fiber, pp. 4-36, Vol. 14(1) January 1982.
4. Hill, T.K., and W.W. Joseph, "Energy-Absorbing Characteristics of Materials," SLA74-0159, Sandia Laboratories, Albuquerque, NM, May 1974.
5. Knoell, C., "Environmental and Physical Effects on the Response of Balsa Wood as an Energy Dissipator," National Aeronautics and Space Administration, Jet Propulsion Laboratory Technical Report No. 32-944, California Institute of Technology, Pasadena, CA, June 15, 1966.

CONDITIONS

The following changes have been made to the certificate:

Condition No. 5(a)(3) was revised to include the latest revisions of the licensing drawings.

Condition No. 10 was updated to authorize use of Revision No. 16 of the certificate of compliance until February 28, 2020.

The references section has been updated to include this request.

CONCLUSION

Based on the statements and representations contained in the application and the conditions listed above, the staff concludes that the design has been adequately described and evaluated, and the Model No. TN-RAM package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9233, Revision No. 17 on February 22, 2019.