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Review Guidance for the Safe Transport and Dry Storage of High Burnup Spent Nuclear Fuel

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The performance of spent nuclear fuel (SNF) cladding during transportation and dry storage is an important consideration for demonstrating compliance with the safety-based requirements for transportation and dry storage in the United States. The structural performance of the cladding ensures that the fuel performance remains as analyzed for the transport duration or approved dry storage period. Historically, the U.S. Nuclear Regulatory Commission (NRC) has discussed considerations for ensuring adequate cladding performance through safety review guidance. This guidance has defined adequate fuel conditions, including peak cladding temperatures during short-term loading operations to prevent and mitigate degradation of the cladding. The U.S. NRC has recently supplemented the technical basis in support of the existing guidance on cladding performance by issuance of two draft reports for public comment, NUREG-2224, "Dry Storage and Transportation of High Burnup SNF"and NUREG-2214, "Managing Aging Processes in Storage Report". This paper will discuss the technical conclusions in these documents and their implications to the regulatory framework for the safety review of high burnup SNF (i.e., SNF with burnups exceeding 45 gigawatt-days/metric ton of uranium). NUREG-2224 addresses the technical issue of hydride reorientation, a process in which the orientation of hydrides precipitated in high burnup SNF cladding during reactor operation changes from the circumferential-axial to the radial-axial direction. NUREG-2224 provides a technical assessment of results from NRC-sponsored research on the effects of hydride reorientation on high burnup SNF cladding performance. NUREG-2224 also provides example approaches for licensing and certification of high burnup SNF for dry storage and transportation, which aim to clarify NRC's expectations for supporting data on high burnup SNF performance for the evaluation of design-basis drop accidents and vibration normally incident to transport. These approaches recognize the increased flexural rigidity imparted by the fuel pellets on the cladding' s mechanical performance. NUREG-2214 provides a generic evaluation of the age-related mechanisms that have the potential to challenge the ability of SNF cladding to support important-to-safety functions of dry storage systems for periods up to 60 years. These mechanisms consider that time-dependent changes to the cladding are primarily driven by the fuel's temperature, internal pressure-induced cladding hoop stresses, and the environment during storage or transport operations. Both NUREG-2224 and NUREG-2214 clarify the technical position of the NRC on high burnup SNF performance, which will help improve the effectiveness and efficiency of the review process for applications for dry storage and transportation.

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