NEUP Nuclear Energy University Program
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Novel Lightweight Material for Spent Nuclear Fuel Transportation

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ABSTRACT:

In this proposed research, an interdisciplinary team from the Department of Mechanical and Aerospace Engineering and the Department of Civil, Construction, and Environmental Engineering at North Carolina State University (NCSU) will work with a small business to model, design, prototype, and test high-strength and cost-effective lightweight Composite Metal Foam based impact limiters for spent nuclear fuel (SNF) and high-level radioactive waste (HLW) structures that meet U.S. Nuclear Regulatory Commission (NRC) certification requirements. The team will also benefit from a direct relationship with one of the leaders in SNF manufacturing who will provide insight on design and testing requirements. In this effort, the North Carolina State University (NCSU) team will focus on modeling and testing 1/8 and 1/4 scale SNF cask impact limiter prototypes made from Composite Metal Foam (CMF) while its small business collaborator – Advanced Materials Manufacturing (AMM), which holds all CMF patents – will design and manufacture all prototypes as those dimensions are outside the manufacturing capabilities of the university.

The project would start with numerical modeling of CMF-based impact limiters for Type B packages at NCSU. Compliance with the requirements of 10 CFR Part 71 would be the primary basis for this task, with particular attention placed on the testing requirements outlined in §71.73 Hypothetical Accident Conditions, especially the Free Drop Test and the Crush Test. Initial small-scale prototypes of impact limiters would then be designed and manufactured at 1/8 scale by AMM and then tested dynamically using the concepts outlined in §71.73 for crush testing at NCSU. The primary purpose of these initial 1/8 scale tests would be to gather the data necessary to properly validate the high-fidelity numerical models that will be used in the design process. The proposed work has clear ties to all four Office of Nuclear Energy (NE) goals, with the strongest ties to the third goal: “Secure and sustain our nuclear fuel cycle”. Safely, economically, and securely managing nuclear waste is a key challenge for plant operators and regulators alike, with robust options for the transportation of SNF being a critical aspect of the process. Developing a CMF-based option for Type B packages would further enhance the safety of SNF transportation at lower cost and reduced weight and volume. This program will benefit both academia and small business sectors by expanding their innovative ideas and introducing them into the nuclear market.