Internal Wireless Sensors for Dry Cask Storage

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Program: FC-4.2: Spent Fuel and Waste Disposition: Storage & Transportation

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ABSTRACT:

A proposed three-year effort will test the performance and reliability of **self-powered, wireless, internal canister sensors** used to monitor canister **temperature and pressure**. The effort will also develop and test a novel approach using an internal microplasma based device for optical emission spectroscopy to **measure gas composition**. Sensors would be installed during canister loading and operate during drying, closure, and throughout the long-term storage period. Testing of the sensors will involve exposure to typical canister drying and long-term storage conditions to assess their performance. A university laboratory testing facility capable of a full-scale mock LWR fuel assembly using heater rods to simulate decay heat will be utilized in testing.

Earlier development and testing of the internal temperature and pressure sensors by Westinghouse Electric Corporation (WEC) have been supported by both industry and DOE to demonstrate performance under typical radiation environments. In this proposed effort, additional radiation shielding will also be designed to further protect the sensors from the radiation environment experienced during long-term dry storage prolonging their life. The WEC wireless sensor system consists of passive devices and utilizes a pulsed induction and receiving method to deliver a pulse from a transmitter that couples energy to the in-canister sensor through metal obstructions (i.e. canister wall, basket, rails, etc.). The coupled energy causes the sensor to resonate at a frequency proportional to the parameter being measured. As called for by the FC4.2 work scope, no cask penetrations are required. Placement would be in an available guide thimble or water rod for example and is accommodating of current cask designs and industry practices for loading, drying, closure, and long-term storage.

The effort will also develop the use of piezoelectric techniques for miniaturization of an internal canister plasma source for optical emission spectroscopy (OES) for use in monitoring canister gas composition during drying, closure, and long-term storage. Monitoring for water vapor provides useful data on effectiveness of the drying operation while in progress. Monitoring for Xe and Kr would be useful to provide indication of fuel failure during drying and during long-term storage. Following drying, radiolysis of any residual water (physisorbed or chemisorbed) in the canister will contribute to the buildup of hydrogen which presents issues for any future ability to retrieve fuel from the canister which is a requirement. OES measuring gas composition during spent fuel drying has been demonstrated by the lead university in an earlier effort where the device was external and sampled gas through a port.

This proposed work represents an excellent combination of more fundamental engineering for sensor development and testing of more mature industry led technologies that need confirmation of reliability and performance in typical canister drying operations and long-term storage environment. This work directly supports the goals of Technical Work Scope FC4.2, "Spent Fuel and Waste Disposition: Storage & Transportation" and builds upon and leverages previous university, industry, and DOE supported efforts on sensor development and development of the full-scale test facility capable of reproducing typical spent fuel handling, drying, and storage procedures and conditions.