AVAILABLE METHODS FOR FUNCTIONAL MONITORING OF DRY CASK STORAGE SYSTEMS

Prepared for

U.S. Nuclear Regulatory Commission
Contract NRC–HQ–12–C–02–0089

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November 2014

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EXECUTIVE SUMMARY

Spent nuclear fuel at a number of U.S. locations is maintained at independent spent fuel storage installations (ISFSIs) in dry cask storage systems (DCSSs). These systems commonly consist of a bolted cask or a welded austenitic stainless steel canister containing spent nuclear fuel. The welded canister is put in a larger concrete overpack or horizontal storage module that is vented to the external atmosphere to allow airflow cooling. A number of technical issues and data needs associated with extended storage of SNF have been identified in the U.S. Nuclear Regulatory Commission (NRC) gap assessment. Following direction from the Commission in SRM–COMSECY–10–0007, NRC staff identified and prioritized the technical information needs (NRC, 2014). Functional monitoring of environmental conditions to assess the condition of safety-significant structures, systems, and components (SSCs) was identified as one of the top priority, crosscutting issues. The purpose of this report is to evaluate the current state of technology for monitoring environmental conditions and the degradation of dry cask components to ensure the safe operation of DCSSs.

A broad literature review of monitoring techniques was conducted for important internal and external environmental conditions (temperature, humidity, chloride concentration, and microbes) affecting materials degradation process, as well as degradation features of welded canister materials, concrete overpacks, cask bolts, and cask internals. Overall, because of geometry, space limitations, and the high ionizing radiation of DCSSs, many of the monitoring methods must either be modified for this application, and all proposed monitoring methods would require testing and validating to assure that the sensors would not affect the performance of DCSS SSCs.

Technologies reviewed to monitor parameters of interest for DCSSs are summarized in Table ES–1 (external and internal environmental conditions, including temperature and relative humidity); Table ES–2 (chloride concentration and microbial activity for the external environment); Table ES–3 (internal pressure); and Table ES–4 (materials degradation inside and outside the system, including canister stress corrosion cracking and potential degradation of the concrete overpack, cask bolts, cladding, and other internal components). Although further assessment is necessary, a variety of techniques are potentially suitable for monitoring component degradation. They include sensors and monitoring methods that have been effectively deployed in nuclear applications as well as in non-nuclear applications, such as chemical process industries, manufacturing, or oil and gas production and refining. Substantial advancement in technology may be necessary for methods that are not presently designed or packaged for field use.

Temperature measurements are routinely performed in nuclear applications using nuclear qualified thermocouples and resistance temperature detectors (RTDs). Other methods for measuring temperature are available but would require significant advancement or development to overcome operational limitations such as (i) having a limited temperature tolerance or unknown radiation tolerance or (ii) requiring complex instrumentation and data analyses.