US NRC-Sponsored Research on Stress Corrosion Cracking Susceptibility of Dry Storage Canister Materials in Marine Environments – 13344

Greg Oberson*, Darrell Dunn*, Todd Mintz**, Xihua He**, Roberto Pabalan** and Larry Miller**
* U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington DC, 20555
** Center for Nuclear Waste Regulatory Analyses, 6220 Culebra Rd, San Antonio TX, 78238

ABSTRACT

At a number of locations in the U.S., spent nuclear fuel (SNF) is maintained at independent spent fuel storage installations (ISFSIs). These ISFSIs, which include operating and decommissioned reactor sites, Department of Energy facilities in Idaho, and others, are licensed by the U.S. Nuclear Regulatory Commission (NRC) under Title 10 of the Code of Federal Regulations, Part 72. The SNF is stored in dry cask storage systems, which most commonly consist of a welded austenitic stainless steel canister within a larger concrete vault or overpack vented to the external atmosphere to allow airflow for cooling. Some ISFSIs are located in marine environments where there may be high concentrations of airborne chloride salts. If salts were to deposit on the canisters via the external vents, a chloride-rich brine could form by deliquescence. Austenitic stainless steels are susceptible to chloride-induced stress corrosion cracking (SCC), particularly in the presence of residual tensile stresses from welding or other fabrication processes. SCC could allow helium to leak out of a canister if the wall is breached or otherwise compromise its structural integrity. There is currently limited understanding of the conditions that will affect the SCC susceptibility of austenitic stainless steel exposed to marine salts. NRC previously conducted a scoping study of this phenomenon, reported in NUREG/CR-7030 in 2010. Given apparent conservatisms and limitations in this study, NRC has sponsored a follow-on research program to more systematically investigate various factors that may affect SCC including temperature, humidity, salt concentration, and stress level. The activities within this research program include: (1) measurement of relative humidity (RH) for deliquescence of sea salt, (2) SCC testing within the range of natural absolute humidity, (3) SCC testing at elevated temperatures, (4) SCC testing at high humidity conditions, and (5) SCC testing with various applied stresses. Results to date indicate that the deliquescence RH for sea salt is close to that of $MgCl_2$ pure salt. SCC is observed between 35 and 80^{o}C when the ambient (RH) is close to or higher than this level, even for a low surface salt concentration.