Thermal Modeling of NUHOMS HSM-15 and HSM-1 Storage Modules at Calvert Cliffs Nuclear Power Station ISFSI

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Abstract:

This report fulfills the M3 milestone M3FT-12PN0810041, ?Report on Realistic Temperature Profiles?, under Work Package FT-12PN081004.
As part of the Used Fuel Disposition Campaign of the Department of Energy (DOE), visual inspections and temperature measurements were performed on two storage modules in the Calvert Cliffs Nuclear Power Station?s Independent Spent Fuel Storage Installation (ISFSI). The inspection procedure included surface temperature measurements on one end of the DSC within the storage module. The data obtained in the inspections at Calvert Cliffs provide an opportunity to develop structural and thermal models that can yield realistic temperature predictions for actual storage systems, in contrast to conservative and bounding design basis calculations.
Detailed models of the concrete storage modules to be examined were developed using STAR-CCM+ (version 7.02; CD-Adapco, 2012). The immediate purpose of this modeling effort is to obtain temperature predictions in actual storage conditions for the module, DSC, and DSC contents, including preliminary estimates of fuel cladding temperatures for the SNF. The long-term goal of this work is to obtain realistic evaluations of thermal performance of actual SNF storage systems over extended periods, which will require developing a detailed COBRA-SFS (Michener, et al., 1987) model of the DSC internals, in addition to the large system models. The approach used in this study omits many of the conservatisms and bounding assumptions normally used in design-basis and safety-basis calculations for spent fuel storage systems. The results of this study cannot be used in licensing basis evaluations of the Calvert Cliffs ISFSI, or any other spent fuel storage facility.
The storage modules used for this study are HSM-1 and HSM-15 in the Calvert Cliffs Nuclear Power Station?s ISFSI, each containing a 24P DSC loaded with 24 CE 14x14 spent fuel assemblies. The total decay heat load for the DSC in HSM-15 was 10.8 kW at the time of loading, and was calculated to be 7.6 kW as of June 2012. The total decay heat load for the DSC in HSM-1 was calculated to be 4.1 kW as of June 2012. Figure S.1 shows an image of the computational volume mesh for the HSM-1 and HSM-15 modules. Figures S.2 and S.3 further illustrate the detailed mesh of these two models with planar slices through the HSM-15 model at the mid-line longitudinally and in the transverse direction.

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