ICET Program Background

Pressurized Water Reactor (PWR) containment buildings are designed both to contain radioactive materials releases and to facilitate reactor core cooling in the event of a Loss of Coolant Accident (LOCA). The cooling process uses water from the reactor coolant system, the emergency core cooling system (ECCS), and the containment spray system that is collected in a containment pool and recirculated to the reactor core to remove residual heat. The containment pool contains a sump screen that protects system structures and components in the flow paths of the containment spray system and the ECCS from the effects of transported debris.

Chemical reaction products may be generated as a result of chemical reactions between the containment spray or ECCS recirculation sump fluids and exposed materials in containment, such as zinc (both zinc coating and galvanized steel), aluminum, carbon steel, paints, copper/copper alloys, concrete, and thermal insulation materials. Evidence supporting the generation of possibly deleterious chemical reaction products is the gelatinous material discovered in the Three Mile Island Unit 2 (TMI-2) containment after the 1979 accident. Concerns have been raised that chemical reaction products in the post-LOCA sump fluid could be generated in sufficient quantity to significantly increase pressure drop across ECCS recirculation containment pool screens. This pressure drop could occur because such products or precipitates could accumulate in the debris beds composed of fibrous and/or particulate containment materials that form on the pool screens.

The NRC and the nuclear energy industry, represented by the Electric Power Research Institute (EPRI), signed a joint Memorandum Of Understanding (MOU) in October, 2004, to conduct testing to address concerns related to the formation of chemical reaction products in the ECCS containment pool [ref. 1]. The integrated chemical effects test (ICET) series was developed as a limited-scope suite of five tests. Each test represents a unique containment pool environment that is intended to represent conditions applicable to a portion of the commercial PWR plants. The primary objectives for the ICET test series are to (1) determine, characterize, and quantify chemical reaction products that may develop in the containment pool under a representative post-LOCA environment; and (2) determine and quantify any amorphous or gelatinous material that could be produced during the post-LOCA recirculation phase. The ICET series was not designed to test the head-loss characteristics or address downstream implications of chemical products observed during testing.

The ICET apparatus consists of a large stainless-steel (SS) tank with heating elements, spray nozzles, and associated recirculation pump and piping to simulate the post-LOCA chemical environment. Unsubmerged and submerged samples of structural metals, concrete, and insulation debris are scaled in proportion to their relative surface areas found in containment and in proportion to a maximum test dilution volume of 250 gal. of circulating fluid. Representative chemical additives, isothermal temperature, and material combinations are established. The system then is monitored while corrosion and mixing occur for 30 days which is comparable to the ECCS recirculation mission time. A complete rationale for the selection of the test conditions and a description of additional test details are provided in the Test Plan [ref. 2]. Note that this version of the test plan supercedes the earlier version attached to the MOU Addendum [ref. 1].

References

[1] "MOU on Cooperative Nuclear Safety Research Between NRC and EPRI: Addendum on Integrated Chemical Effects Testing for PWR ECCS Recirculation," ADAMS Accession Number ML042880402, signed October 4, 2004.

[2] "Test Plan: Characterization of Chemical and Corrosion Effects Potentially Occurring Inside a PWR Containment Following a LOCA", Revision 12.c, ADAMS Accession Number ML051100357, March 30, 2005.