April 19, 2010

MEMORANDUM TO: Michael L. Scott, Chief
Safety Issues Resolution Branch
Division of Safety Systems

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SUBJECT: TRIP REPORT ON STAFF OBSERVATIONS OF GENERIC SAFETY ISSUE 191 RELATED FUEL BLOCKAGE TESTING AT WESTINGHOUSE SCIENCE AND TECHNOLOGY CENTER

On December 1 and 2, 2009, the Nuclear Regulatory Commission (NRC) staff observed a Generic Safety Issue-191-related downstream effects fuel assembly test simulating the flow conditions that could occur during a cold-leg break in Westinghouse 3-loop, Westinghouse 4-loop and B&W reactors. The test was conducted at the Westinghouse Science and Technology center in Churchill, Pennsylvania. Enclosed is the trip report, prepared by staff members, describing the staff's observations.

Enclosure:
As noted

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SUBJECT: TRIP REPORT ON STAFF OBSERVATIONS OF GENERIC SAFETY ISSUE 191 RELATED FUEL BLOCKAGE TESTING OF UPPER PLENUM INJECTION REACTOR DESIGNS AT WESTINGHOUSE TECHNOLOGY CENTER

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Date	04/07/10	04/07/10	04/19/10

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Trip Report
Flow Blockage Testing of a Westinghouse 17 x 17 Fuel Assembly
Simulating Cold-Leg-Break Flow Conditions Through the Core
December 1 and 2, 2009

Background

In response to NRC staff's request for additional information related to topical report WCAP-16793-NP, "*Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid",* the Pressurized Water Reactor Owners Group (PWROG) is performing testing to evaluate in-vessel effects of particulate, fibrous, and chemical debris that pass through the sump strainer following a loss-of-coolant-accident (LOCA). These tests are being conducted by Westinghouse and AREVA on their respective fuel designs using various fiber, particulate, and chemical precipitate debris loads to examine the pressure drop across a single fuel assembly. The tests also examine the effect of the various fuel inlet nozzle designs on debris capture flow blockage. The Combustion Engineering fuel designs are being addressed by Westinghouse. The goal of the tests is to determine the maximum sump strainer debris bypass loads that will not result in unacceptable pressure drops across the mock-up fuel assembly.

In an effort to streamline the staff's review of WCAP-16793-NP Revision 1, NRC GSI-191 technical reviewers Paul Klein (NRR/DCI/CSGB) and Ervin Geiger (NRR/DSS/SSIB) witnessed a cold leg break flow fuel assembly test being performed by Westinghouse at their technology center in Churchill, Pennsylvania. The following is a description of the test and staff's observations. The NRC staff had previously observed a similar test of a hot leg break flow fuel assembly test at the same facility, and that trip report is available in the Agency's ADAMS system (ML083510620).

Discussion

Westinghouse representatives stated that the intent of the current series of fuel blockage tests being conducted at the cold-leg flow rate is to determine the maximum quantity of fibrous debris that would not cause the available driving head in the reactor pressure vessel to be exceeded, irrespective of the quantity of particulate and chemical debris suspended in the circulated fluid. The flow rate through the test fuel assembly was scaled down from that expected for a typical 4-loop Westinghouse plant.

The test assembly is shown in Figure 1. The test article (fuel assembly) consisted of a single 17x17 Westinghouse fuel assembly incorporating the Westinghouse bottom nozzle and P-grid. The test article is full scale in cross section but not in height or number of spacer grids. The length of the test assembly is about 48 inches (approximately one-third the length of an actual fuel assembly) and includes 1 protective grid, 4 spacer grids and 1 mixing-vane grid. NRC staff found the test set-up, debris preparation, coolant flow parameters and test acceptance criteria to be prototypical and, therefore, acceptable.

Westinghouse had determined (through previous testing) that for a cold-leg break, 18 grams of fiber per fuel assembly is about the maximum fiber load that can be tolerated at low particulate to fiber ratios when chemical precipitates are present in the circulated fluid. Therefore, a series of cold-leg flow rate tests are being performed over a range of particulate-to-fiber ratios to provide confidence that a limiting fiber to particulate ratio is identified.

NRC Staff Observations

The NRC staff observed a test identified as CIB32 conducted at a particulate to fiber ratio of 45:1 (weight basis). Initially, 810 grams of silicon carbide particulate were added to the test loop, followed by 18 grams of fiber. After the pressure drop across the test assembly stabilized, the first 415 gram batch (37.8 liters of 11 g/l solution) of WCAP-16530-NP aluminum oxyhydroxide precipitate was added. The addition of the chemical precipitate immediately caused a steep increase in pressure drop across the fuel inlet nozzle/P-grid that gradually decreased with time. The addition of the second batch of chemical precipitates had minimal affect on the pressure drop. At no time during the test did the pressure drop exceed the test acceptance criterion that is based on the available driving head for a cold-leg break.

Upon disassembly of the test article, the NRC staff observed that fiber and particulate were captured primarily at the fuel inlet nozzle/P-grid. Very little fiber was observed to be captured at the other spacer grids. The concentration of debris at the inlet nozzle/P-Grid elevation is different than the multi-elevation distribution of debris observed for tests at hot leg break flow rates.

Conclusions

- The particulate-to-fiber ratio that results in the peak pressure drop across the fuel assembly is different for hot leg break and cold leg break flow conditions.

- If the fuel assembly debris bed is not already saturated with particulate, the WCAP-16530-NP aluminum based chemical precipitates can cause a significant pressure drop across a fibrous debris bed.

- At low fiber loads and with cold leg break flow conditions, the bulk of the fiber appears to be captured at the first debris filter (P-grid). This phenomenon may be due to the reduced flow rates not driving debris further into the core.

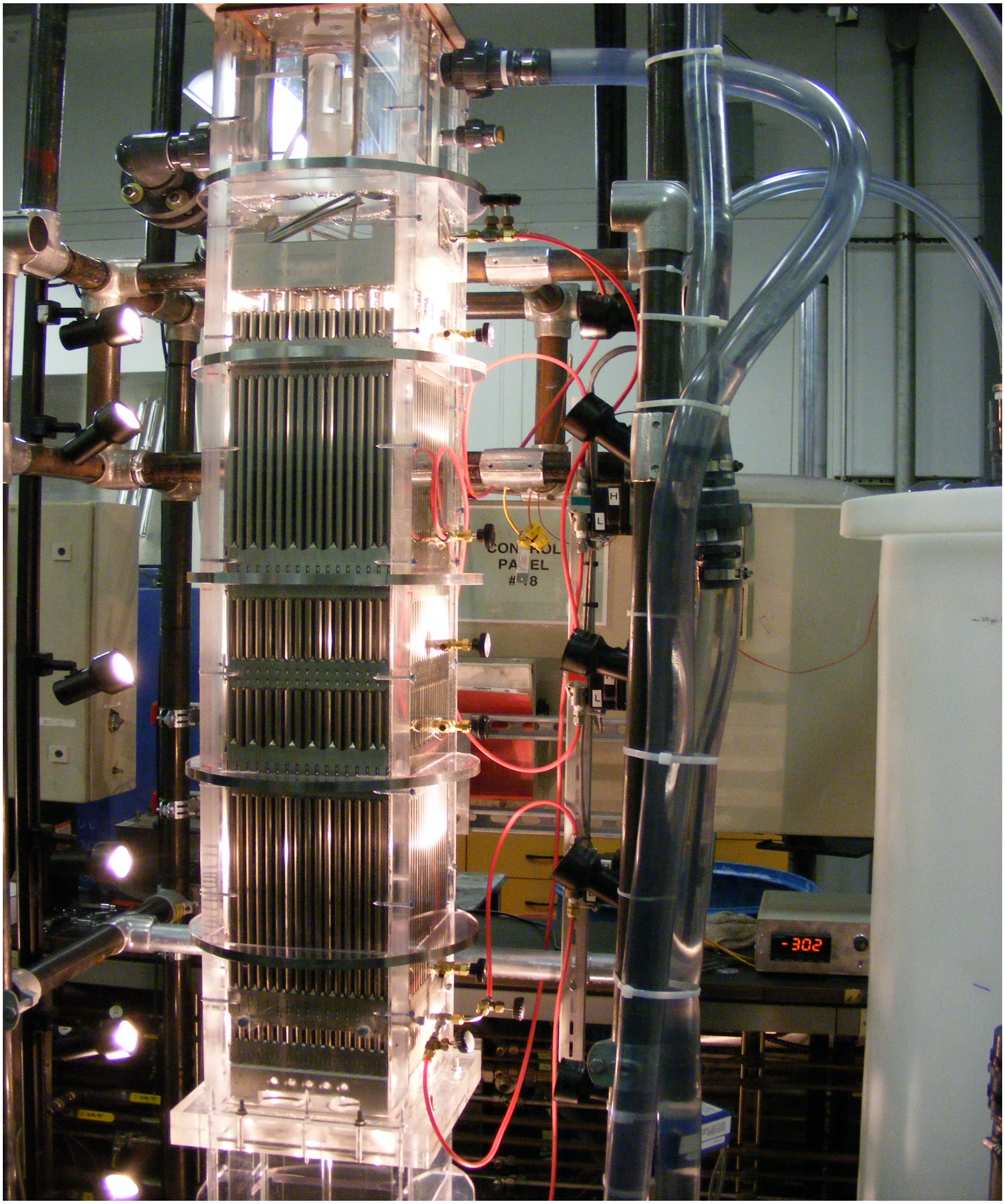

Figure 1: Test Assembly