April 7, 2009

MEMORANDUM TO: Donnie Harrison, Acting Chief
Safety Issues Resolution Branch
Division of Safety Systems

FROM: Ervin Geiger */RA/*
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Office of Nuclear Reactor Regulation

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

On February 26, 2009, the Nuclear Regulatory Commission (NRC) staff observed a Generic Safety Issue-191-related downstream effects fuel blockage test that simulated the down-flow conditions that occur during a cold-leg break in a Westinghouse 2-loop reactor with upper-plenum injection. The test was conducted at the Westinghouse Science and Technology center in Churchill, Pennsylvania. Enclosed is the trip report, prepared by staff members, describing their observations.

Enclosure:
As noted

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ADAMS ACCESSION NO.: ML090780179 NRR-106

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Date	03/19 /09	03/20/09	04/07/09

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Trip Report
Flow Blockage Testing of a Westinghouse 17 x 17 Fuel Assembly
Simulating Flow in an Upper Injection 2-Loop Westinghouse PWR
February 26, 2009

Background

As a follow up to the NRC's review of 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 debris and chemical precipitates 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 ultimate goal of the tests is to determine the maximum sump strainer debris bypass loads that result in acceptable pressure drops across the mock-up fuel assembly.

In an effort to streamline the staff's review of the anticipated revised WCAP-16793-NP, NRC GSI-191 technical reviewers Paul Klein (NRR/DCI/CSGB) and Ervin Geiger (NRR/DSS/SSIB) witnessed one such fuel assembly blockage test being performed by Westinghouse at their technology center in Churchill, Pennsylvania. The following is a description of the test and staff's observations.

Discussion

Prior to beginning the test, Westinghouse described the intent, protocol, and parameters of the test NRC staff were about to observe. Westinghouse stated that the intent of the upper plenum injection (UPI) fuel blockage test was to demonstrate that the debris loads qualified in the flow blockage tests conducted for the cold-leg injection plants also resulted in acceptable pressure drops for the UPI plants. The flow rate used in the UPI test was scaled down from that expected for a typical 2-loop plant with a core having 121 fuel assemblies. The debris load and debris characteristics were the same as that used for the 4-loop Westinghouse plants. Note: NRC staff questioned whether including calcium silicate in the debris mix was conservative since earlier fuel assembly tests had shown calcium silicate addition lowered the overall pressure drop and some UPI plants may not have calcium silicate in their debris mix. After some discussion, Westinghouse representatives decided to perform the test without calcium silicate.

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. An upper internal structure was added to the assembly to simulate actual physical conditions in the reactor pressure vessel (RPV). The test article was full scale, except for height and number of spacer grids. The length of the test assembly was about 48 inches, approximately one-third the length of an actual fuel assembly. The test assembly included 1 protective grid, 4 spacer grids and 1 mixing vane grid.

The flow rate through the test article was maintained constant at approximately 17 gpm to simulate a total UPI flow of 2000 gpm through the RPV. Initially, 29 lbm of particulate, in the

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form of silicon carbide, was added to the loop and allowed to circulate in the loop for several turnovers. Next, 200 grams of fiber was added in 10-gram increments allowing for a minimum of two fluid turnovers between each addition. Finally, 10 lbm of chemical precipitate was added in two 5-lbm batches, allowing for several turnovers between chemical precipitate batch additions.

The temperature of the recirculated water was maintained at room temperature (approximately 70° F) and the pH was monitored.

Staff Observations

Before beginning the actual test, staff reviewed the test protocol documents, observed the test setup, and examined the debris (fiber, particulate, and chemical precipitate). Staff observed the initiation of the test, the gathering and recording of data, and the addition of debris. As documented in a previous trip report (ADAMS Number ML083510620), the NRC staff had evaluated the debris preparation technique and the size distributions of fuel assembly test debris compared to actual strainer bypass debris sizes. The staff judged the preparation of debris and method of introduction into the test loop to be acceptable. Also, the staff agreed that the partial length mock fuel assembly was sufficiently representative of an actual fuel assembly and that it allowed for a more realistic debris distribution throughout the fuel assembly as compared to the much shorter/single spacer grid test assembly used in previous tests observed by NRC staff.

The staff observed that the total pressure drop across the fuel assembly increased over time with fiber additions. Comparison of pressure drop measurements between the top nozzle/1st grid support and the full assembly indicated that the initial collection of debris occurred at the top of the fuel assembly but quickly distributed over additional spacer grids. At no time during the test did the pressure drop exceed the acceptance limit of 13 psi across the fuel assembly.

Photographs of the disassembled test article (Figures 2 and 3) indicated that fiber and particulate were relatively uniformly distributed among the spacer and mixing grids with sufficient channels to maintain flow.

Documentation

The test procedures and test results were classified “proprietary” by Westinghouse. Therefore, the staff has not attached a copy of the test procedure to this trip report. Westinghouse stated that the protocol and results will be submitted for NRC review as proprietary documents in support of the revised WCAP-16793-NP.

Conclusions

The observed fuel blockage test with scaled flow rate, scaled debris load, scaled 1/3 height fuel assembly, and simulated gap between fuel assemblies is considered representative of the specific type of Westinghouse fuel assembly for the UPI plants and debris load being tested. In previous meetings, the PWROG stated that WCAP-16793-NP will provide guidance for the maximum amount of debris loading conditions that will result in acceptable pressure drop across the reactor core. The guidance will be based on the results of the tests of the various fuel designs using the various combinations of debris loads. The NRC staff plans to review the complete set of test data as part of the review of a revision to WCAP-16793-NP.

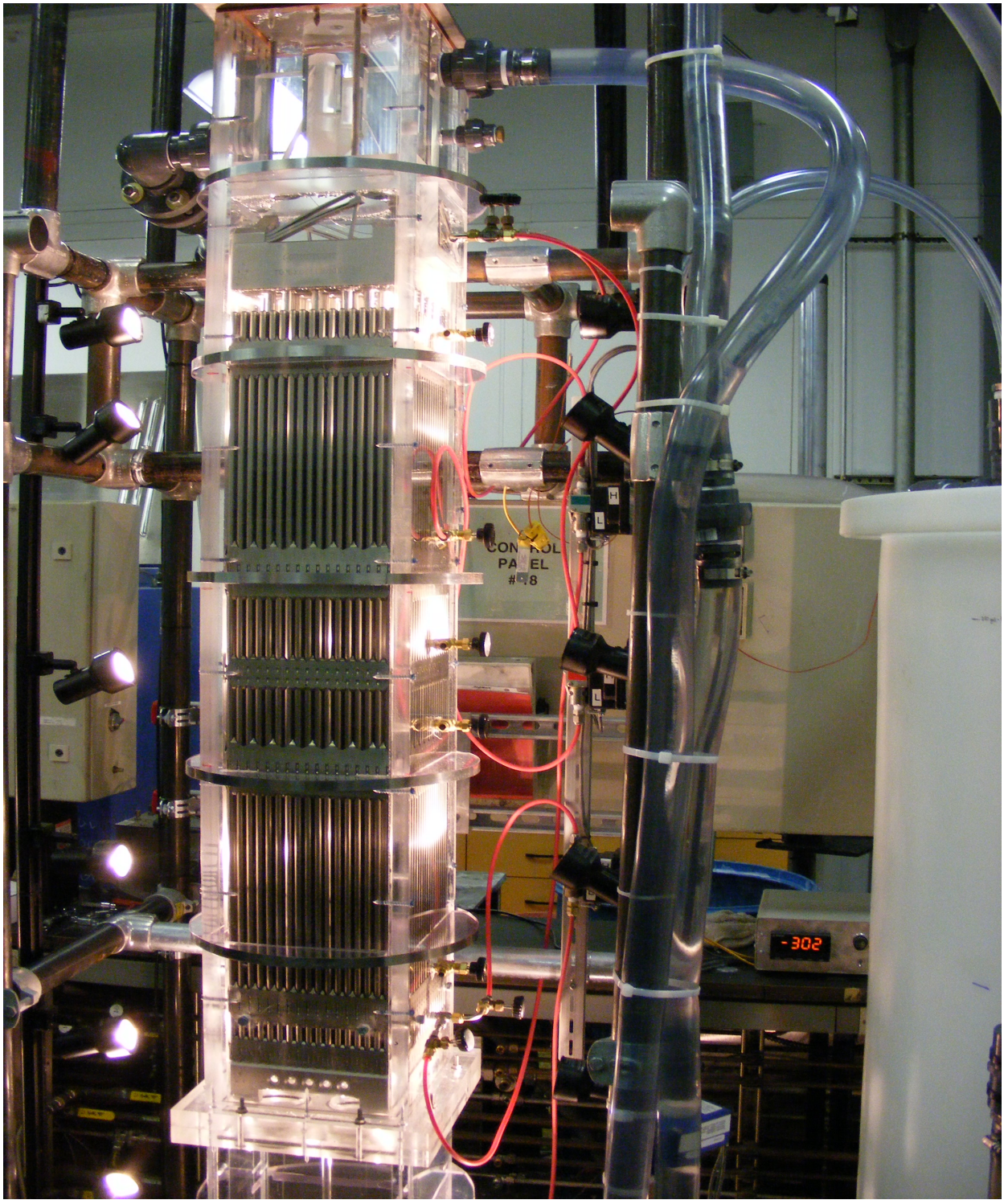

Figure 1: Test Assembly

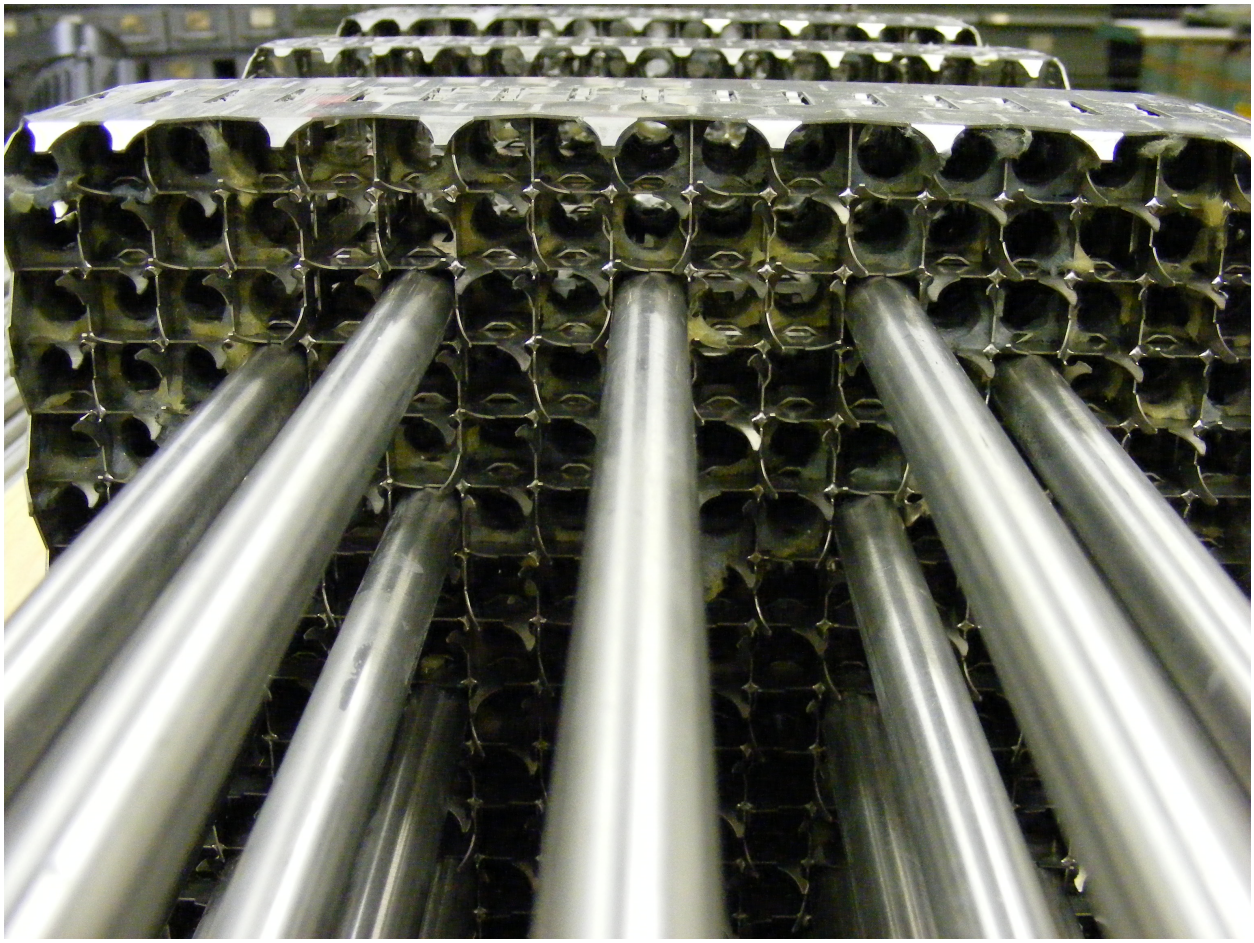

Figure 2: Top View of Debris Deposited at Mixing Grid

Figure 3: Close-Up View of Debris Deposited at Mixing Grid