August 14, 2013

MEMORANDUM TO: Gloria Kulesa, Chief
Steam Generator Tube Integrity & Chemical Engineering Branch
Division of Engineering

Stewart Bailey, Chief
Safety Issues Resolution Branch
Division of Safety Systems

FROM: Stephen Smith */RA/*
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Steam Generator Tube Integrity & Chemical Engineering Branch
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Office of Nuclear Reactor Regulation

SUBJECT: TRIP REPORT FOR JULY 2013 NRC STAFF VISIT TO THE UNIVERSITY OF NEW MEXICO TO OBSERVE CHEMICAL EFFECTS TESTING FOR SOUTH TEXAS PROJECT

On July 11-12, 2013, NRC staff visited the University of New Mexico (UNM) in Albuquerque, NM to observe chemical effects related testing being performed for the South Texas Project. Testing was related to the South Texas Project pilot to resolve Generic Safety Issue (GSI) 191 using a risk informed approach. During the visit, the NRC staff observed testing and discussed the licensee's chemical effects methodology. Enclosure 1 contains the NRC staff trip report. A list of participants in the discussions at UNM is provided in Enclosure 2.

Enclosures:
As noted

CONTACT: Paul Klein, NRR/DE/ESGB
301-415-4030

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ADAMS Accession No.: ML13226A239

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NAME	PKlein	MDiaz-Colon	MYoder	SSmith
DATE	08/15/2013	08/14/2013	08/14/2013	08/14/2013

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Enclosure 1

Trip Report
Testing at University of New Mexico
Evaluating Potential Chemical Effects for South Texas Project
July 11-12, 2013

Background

South Texas Project is piloting a risk-informed approach to resolve GSI-191. The licensee is sponsoring work at a number of facilities and the chemical effects related testing is being performed at the University of New Mexico (UNM) in Albuquerque, NM.

In an effort to improve the staff's understanding of these tests, and to better support a review of a risk informed license amendment request and exemption requests from the licensee, technical reviewers Matthew Yoder, Paul Klein, Marioly Diaz-Colon (NRR/DE/ESGB), and Stephen Smith (NRR/DSS/SSIB) observed testing on July 11-12, 2013. Prior to the visit, the Nuclear Regulatory Commission (NRC) staff and South Texas Project representatives had multiple pre-submittal meetings[1] to discuss various aspects of the licensee's risk informed methodology. The following provides a description of the chemical effects testing and highlights from discussions between the NRC staff and the licensee.

Discussion

The testing at UNM consists primarily of Chemical Head Loss Experiment (CHLE) loop tests, supplemented by smaller scale bench testing. Figure 1 shows a photograph of the CHLE test loop that includes: (1) a tank that exposes plant materials to either submerged or spray conditions, (2) three parallel vertical loops that measure pressure drop across a debris bed built on a flat perforated plate, and (3) associated pumps and piping. The tank is insulated and contains heaters to support elevated temperature operation. The maximum operating temperature of the CHLE loop is approximately 185^{o}F. During the initial phase of the test, fluid enters the tank through spray nozzles in the upper portion of the tank and through headers in the lower portion of the tank. Tank spray flow is shut off at the point in the test representing the termination of post-LOCA containment spray system flow.

The three identical vertical head loss loops are designed to operate either in parallel, when connected to the CHLE tank, or individually when isolated from the tank. Each loop has an independent pump so that the flow to each test screen can be separately controlled. For the STP tests, the nominal velocity through the screen area during testing was 0.01 ft/s. Prior to test commencement, fiber is introduced at the top of each column to build a debris bed on the horizontal perforated plate test specimen. The beds are formed under a 0.1 ft/s velocity. The use of a clear polycarbonate piping spool section permits visual observation of the debris bed

[1] Summaries of the meetings held on June 2, July 7, July 26, August 22, October 3, November 1, November 2, and December 1, 2011, and February 9, March 1, and March 8, 2012, are available in ADAMS Accession Nos. ML111640160, ML111950094, ML112130165, ML112411419, ML112840114, ML113120129, ML113180196, ML113430087, ML120620541,ML120830103, and ML120830086 respectively.

during formation and subsequent testing. Trisodium phosphate (TSP) is added to the test over a one hour period beginning 15 minutes from test initiation.

Figure 1. Chemical Effects Head Loss Tank (left) and head loss columns (right).

During the visit, the NRC staff observed the final two days of a ten day test (T5) in the CHLE test loop, including shutdown and removal of the tank materials and the vertical loop debris beds. After removal from the test loop, an unevenly distributed brownish deposit was evident on the top of the debris beds. The staff also observed the bench test facility and some limited ongoing bench tests. The staff had discussions with STP personnel, their contractors, and representatives from the Pressurized Water Reactor Owners Group (PWROG). Those discussions focused on results from chemical effects testing performed to date. Highlights from the discussions include:

- The staff expressed appreciation for the opportunity to visit and observe chemical effects related testing at UNM. The NRC staff gained insights into the STP chemical effects testing that improved our understanding of the licensee's risk informed license amendment request.

- The NRC staff reiterated that debris beds formed in the CHLE vertical loops with fiber prepared using the Nuclear Energy Institute (NEI) pressure washer methodology are not responsive to chemical precipitates. Therefore, the staff considers these beds to be inadequate for tests designed to detect chemical precipitates. The staff repeated their concern about the use of test fluid turbidity as the primary diagnostic to detect the formation of chemical precipitates since turbidity measurement will not detect formation of precipitates within the debris bed. The staff is also aware of a chemical effect test at another facility where filtering identified the presence of a precipitate in the test fluid that was not accompanied by a change in the fluid turbidity.

- Test beds made with blended fibers demonstrate significant pressure drops when chemical precipitates are present. CHLE tests with blended beds, however, did not exhibit stable baseline head loss, which complicated the interpretation of chemical effects tests. Previous tests at other facilities using blended beds have been able to achieve stable baseline head loss. It is not known if differences in fiber preparation techniques or test operating parameters are causing the variability in blended bed baseline head loss in the CHLE loop.

- Column 3 in the three parallel vertical head loss loops tends to experience the greatest pressure drops across the test bed for reasons that are not understood.

- The staff questioned if the CHLE tank velocities past the submerged coupons was reasonably representative of velocities in a post-LOCA containment pool. The licensee showed results from a computational fluid dynamics (CFD) plot of the CHLE tank with test coupons in place. The CFD showed relatively low velocities past the coupons. STP had not performed a comparison between the velocities predicted in the loop and those predicted for a post-LOCA containment pool. The staff stated that STP should perform a comparison and if there are differences in the flow rates that STP should evaluate whether the dissolution of materials and the potential for precipitates to form could be affected.

- A corrosion product formed on the galvanized steel coupons during the ten day T5 test. Analysis of similar product from earlier tests revealed that it is a zinc phosphate. Although the CHLE results indicate that the zinc phosphate tends to stay attached to the galvanized steel coupon surface, the NRC staff questioned if water falling from a break could dislodge the precipitate and if so, how that may affect head loss across a sump strainer.

- The licensee's risk informed submittal relies on two 30-day chemical effects tests, T1 and T2, that used beds prepared with the NEI pressure washer method. The licensee stated that the lack of a stable, repeatable baseline head loss with blended beds was the rationale for using fibers prepared by the pressure washer method. The medium break loss-of-coolant accident (MBLOCA) test included a fiber amount associated with a 6-inch pipe break. The large break (LBLOCA) test included a fiber amount based on an average of several 15-inch breaks (using a 17D ZOI).

- The staff noted that the intent of the approval of the NEI fiber preparation methodology was intended to allow an alternate means of preparing (especially fine) fibrous debris

without using methods that result in a non-prototypical amount of fiber shards. The intent is to create mostly individual fibers that are easily suspended (class 2) with a lesser amount of class 3 (small clumps) and class 1 (shards) to match the NEI 04-07 fiber size distribution. Some of the photos in the test reports appeared to indicate that there was an excessive amount of class 3 fibers in the prepared debris. The staff also stated that they were concerned that the use of NEI fiber in vertical loop testing would result in a non-prototypical bed because the fiber is allowed to settle by gravity onto the perforated plate instead of transporting with flow as it would in the plant.

- Tests T3 and T4 were non-representative 10 day CHLE tests designed to force precipitation by including an approximately 100X increase in aluminum surface area and by the selected test temperature profile. Test T4 had only aluminum and fiberglass materials. Direct bed comparisons were made in each test by using a blended fiber bed in columns 1 and 3 and a NEI protocol fiber bed in column 2. STP presented the results of these tests and concluded that blended bed head losses observed in these tests were consistent with decreased dissolved aluminum concentration and increased turbidity measurements. The NEI protocol beds did not exhibit a similar head loss response due to precipitate formation. The NRC staff noted that in Test T4, column 3 showed an earlier rapid head loss increase that coincided with a small decrease in dissolved aluminum but without an increase in turbidity.

- Although the NRC staff has questions concerning the chemical effects tests, when considered in total, these tests suggest the STP plant-specific chemical effects will be less significant than tests using pre-mixed WCAP-16530 precipitate.

- The NRC staff also noted that there are some post-LOCA conditions that were not represented in these tests such as the presence of radiation, the presence of activated primary system particulate dislodged by the LOCA and presence of unqualified alkyd type coatings.

- The staff questioned the potential range of pH in the STP post-LOCA pool and indicated that calculations for most plants show a potentially greater pH range following a LOCA than was indicated for STP.

- STP discussed the probability density functions for the chemical effects bump-up factors in their submittal. The basis for the submittal was the first two thirty-day tests performed (T1 and T2) and other industry testing. Dissolution was predicted using the WCAP-16530-NP-A methodology for STP conditions and evaluated using thermodynamic equilibrium modeling predictions for solubility limits. The STP bump up factor probability density functions for chemical effects were constructed using engineering judgment. Although the probability density functions are based on engineering judgment, STP personnel stated that they believe them to be conservative.

- The licensee provided a short presentation related to sensitivity studies that could be performed to evaluate how changes to various parameters could be evaluated for relative importance.

Summary

At the completion of the two day visit the NRC staff stated that they have a better understanding of the STP risk informed chemical effects evaluation. The NRC staff also stated that the STP submittal review will be a challenge since the exponential probability density functions for chemical effects bump-up factors rely on engineering judgment.

ENCLOSURE 2. Attendees

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[1] Participated via phone.