12/30/03

NRC Comments on Industry's Test Plan, "Characterization of Corrosion Product Release During a PWR LOCA Event."

(*Preliminary Draft for Discussion Only*)

COMMENTS FROM OFFICE OF NUCLEAR REGULATORY RESEARCH (RES) & LOS ALAMOS NATIONAL LABORATORY (LANL)

1. The test matrix is made up of extremes ("max." and "min."), and in these complex, multi-component, and rather low temperature systems, there are many idiosyncracies in solubility, retrograde solubility, and reaction coefficients. It could very well be that a "worse" case is not at some combination of end points - the fact upon which the test matrix is predicated - but at some intermediate combination of temperatures, concentrations, time, etc.

2. ZOI debris such as fiber glass were not included either as test coupons or filter bed. This debris could potentially be a source of filtration and leaching, and place for nucleation of precipitants.

3. Other than HCl, why there is no mention of silica, NaOH, borate or pH control?

4. Is it realistic that the temperature of the solution should be cycled up and down?

5. Proper scaling will be needed to match expected conditions of dilution, timing, silica concentration, etc.

6. Should be aware that pre-existing surface corrosion may be an important source of soluble metal that immediately contributes to the solution inventory.

7. Background cites ORNL reports as evidence of no significant corrosion of carbon steel. Those tests examined structural integrity, not corrosion of low solubility metal in the containment pool.

8. Direct measurement of corrosion product mass would be difficult.

9. What about plans for non-qualified coating tests? Superseded by this effort?

10. If concerns are found with combined samples, should be prepared to pursue separate tests to identify primary contributors.

COMMENTS FROM OFFICE OF NUCLEAR REACTOR REGULATION (NRR)

The following preliminary comments were prepared by the staff of Materials and Chemical Engineering Branch of the Division of Engineering, Office of Nuclear Reactor Regulation (NRC/NRR/DE/EMCB) on the proposed industry test plan. In order to properly evaluate the industry test plan, however, more information is needed from the industry. A separate document that contains questions for industry was also provided. The following comments have been grouped according to the headings in the proposed industry test plan.

Abstract

- The industry test plan is designed to: 1) determine the pressure drop across the containment sump screen in various post-LOCA environments due to corrosion products from zinc and aluminum; and 2) provide data for developing a mathematical model for corrosion product release that will calculate corrosion product release rates under post-LOCA conditions. The test objective is to determine whether gelatinous reaction products may develop in a representative time-temperature-chemistry regime of a LOCA event. If a gel forms, the test parameters that promote gel formation and the gel's effects on system recirculation would be evaluated. Since the test objectives appear to be different, agreement would need to be reached on the test objectives if the NRC and industry are going to collaborate on a single test.

Background

- It is important to obtain the industry data that provided the basis for their stated amounts of zinc and aluminum in a typical containment building. If these values are based on only a few plants, we need to obtain information from additional plants to ensure test parameters bound industry conditions. Otherwise, the test results will be constantly challenged.

- The proposed test plan indicates carbon steel is not expected to experience significant corrosion. Industry should provide the basis for this assumption. Would they expect carbon steel corrosion to be significant in a longer duration test (e.g., 30 days)?

- What industry information is readily available concerning insulations, non-metallic, and metallic components in containment? Has the effect of insulation type been investigated?

Proposed Test Plan

- The construction materials for the proposed test loop is not identified but it should be fabricated from corrosion resistant alloys.

- A schematic of the test loop arrangement shows some important differences from plant conditions. For example, both a pump and heat exchanger are shown upstream of the filter media. The pump may break up corrosion products prior to them passing to the filter. Temperature differences in the heat exchanger may cause deposits to form in the heat exchanger instead of being collected at the filter media. Some coupons will be alternately immersed rather than be exposed to a fine spray.

- What portions of the proposed 550 ft^2 surface of zinc in the test will be in the form of galvanized structure and paint? What will be the application method, curing time, and aging of the zinc primer coupons.

- The industry proposed plan states "The levels for each of these independent variables have been selected to span the range of conditions that could occur in a LOCA." Does industry have sufficient data to conclusively say test conditions effectively bound actual expected plant conditions?

- If the condition for flocculation exists in the sump, precipitation reactions will be driven not only by the sump temperature but also by the water chemistry, especially by pH. We think pH should be included as an independent variable listed in Table 1.

- Table 2 provides independent variable levels for the proposed test runs. We agree that it is not possible to predict the "worst" combination for promoting gel formation. A test using the following combination of test parameters should be considered : (agitation +, aeration +, HCl +, submersion +, containment temperature +), and (TSP -, sump temperature -).

- Given the TMI gelatinous material analysis, should test coupons or other sources for some of these elements (e.g., Cu, Fe, S, Ni) be included in tests? Should some concrete dust be included in addition to concrete coupons?

- Given the significant corrosion effects produced by aeration, more information comparing test plan conditions to actual containment conditions is warranted.

- Corrosion product generated during the test may deposit on areas other than the filter. How will the system cleanliness be verified prior to each new run to ensure deposits from previous tests don't influence current test results?

- What ASTM or other standards will be used for weight loss measurements? Will weight loss measurements be performed before or after cleaning corrosion products from the test coupon? Will corrosion product characteristics (e.g., friable, tenacious) be recorded?

- Identify the basis for the stated typical zinc surface area to volume ratio (0.75 gal/ft^2). Should this ratio be considered typical or bounding for the industry? How many plants were studied to determine this value?

- More than one test run may be necessary to sufficiently measure the effects of NaOH on pH and the sump pool environment relative to TSP.

- **A 4 day test duration is too short.** What is the longest period that recirculation will be used post-LOCA? The test duration and temperature profile should be representative of plant conditions for post-LOCA recirculation. Initial longer duration tests may indicate a shorter test duration is acceptable.

- Test loop design should include a bypass around the filter such that testing may continue if the filter becomes clogged. This bypass loop could contain a bed of insulation material.

- Repeating one of the test runs does not seem sufficient to determine random error. We recommend a minimum of three runs for one of the test conditions that produces deposits.

- Given the number of test variables and the complexity of variable interaction, simple averaging to determine the effect of the independent variable on the dependent variable seems ambitious. For example, one dependent variable in the test is a pressure drop

across the fiber glass bed fouled by the chemically generated material. Change of this pressure drop due to fouling represents a measure of the effect caused by the chemical species generated in the sump. Since for each test a new fiber bed, having slightly different physical characteristics is used, a pressure drop across two different fiber beds may be different. In comparing the results from two tests it may be difficult to distinguish differences between chemical effects and differences in fiber beds when small amounts of corrosion product are deposited.

- We are not familiar with the coatings debris testing currently being planned by EPRI in support of GSI-191 resolution.