November 19, 2009

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

FROM: John Lehning, Reactor Systems Engineer
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SUBJECT: SUMMARY OF TELECONFERENCE HELD ON OCTOBER 26, 2009, WITH ALION AND PARTICIPATING PRESSURIZED-WATER REACTOR LICENSEES REGARDING TESTING TO DETERMINE FIBERGLASS EROSION IN A POST-LOSS-OF-COOLANT ACCIDENT CONTAINMENT POOL

On October 26, 2009, the (NRC) Nuclear Regulatory Commission staff participated in a teleconference with Alion Science and Technology to discuss Alion's plan to perform additional testing to determine the percentage of Nukon low-density fiberglass debris generated during a loss-of-coolant accident (LOCA) that would erode in the post-LOCA containment sump pool over a 30-day time period. The relevance of the erosion phenomenon to containment sump strainer performance is that, although certain sizes of debris pieces may not be capable of transporting to the strainers in an intact form, when exposed to flow in the post-LOCA containment pool, fine fragments of these debris pieces may gradually be released and transported to the strainers, resulting in an increase in strainer head loss.

Background

The NRC staff had identified potential issues with earlier low-density fiberglass erosion testing that had been performed by Alion. One of the main concerns was that significantly different behavior appeared to be present in the short-term erosion test data (i.e., up to a 48-hour test duration) as compared to the long-term test data (i.e., between 60-hour and 30-day test duration). Specifically, the long-term data unexpectedly showed lower cumulative erosion percentages and a different (slightly decreasing) cumulative erosion trend as compared to the short-term data. The staff had previously observed similarly unexpected behavior in another set of erosion tests performed by a different vendor; in neither case has an adequate explanation been proposed for the significant differences in short-term and long-term behavior.

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Additional issues identified by the staff regarding the Alion erosion testing included concerns with the prototypicality and uniformity of the fluid velocity and turbulence in the test flume, the representativeness of the processes used to prepare the debris pieces used for testing, and the size of the holes in the perforated sample plate used to hold the debris pieces in place.

As part of Alion's effort to address the issues raised by the NRC staff, further erosion testing was proposed to provide additional low-density fiberglass erosion data. Alion's intent was to perform the additional erosion tests under more controlled conditions that would eliminate sources of uncertainty that may have affected the results of the existing erosion tests. The purpose of the teleconference was for the NRC staff to provide feedback to Alion concerning the planned erosion testing.

Call Summary

The main points the NRC staff discussed with Alion during the teleconference are summarized below.

1. The NRC staff cannot determine whether Alion's proposed matrix of additional tests will be adequate to justify the intended result of 10% erosion prior to the performance of the tests and review of the resultant data. While the staff concluded, based in part on the number of samples to be used and increased test procedure controls, that it is possible that the planned additional testing will provide sufficiently consistent and coherent data to justify the intended result, clearly the outcome of the additional tests cannot be predicted. The staff further stated that it was appropriate to consider both the results from the planned additional testing, as well as the existing test data, as applicable, in determining a 30-day cumulative erosion percentage.

2. The staff stated that one of the most critical aspects of the testing would be demonstrating that the cumulative erosion percentage is trending toward an asymptotic value that does not exceed the 30-day cumulative erosion percentage that Alion is attempting to justify. Alion's means of collecting eroded fines to determine the trend in the cumulative erosion percentage was being examined in shakedown testing at the time of the call and had not yet been demonstrated to be effective. The staff emphasized that it would be important to obtain useful data from this measurement and that this data should trend consistently with the information obtained from comparing the pre-test and post-test masses of the test debris pieces.

3. The staff stated it would be important to minimize pre-test losses from the test debris, or else account for these losses if they cannot be reduced to a negligible level. The staff considered mass losses following the shredding of the debris into small pieces, through normal handling or preparation processes such as boiling, as representing material that would likely be removed during an erosion test. Alion stated that pre-test handling losses were expected to be minor due to procedural controls. Alion further stated that the percentage weight change observed in the debris pieces as a result of boiling was somewhat less than the weight percentage of organic binder present in manufactured fiberglass (which boiling is intended to remove). As such, Alion concluded that the release of fine fragments from the pieces of shredded fiberglass during boiling was not significant. The staff considered Alion's argument reasonable, but suggested that the

vendor continue to be attentive to the potential for mass loss during handling and particularly during boiling. The staff noted that filtering the water used to boil the fiberglass samples and (if a significant amount of fines is collected) weighing any filtered fines released would reduce uncertainties associated with pre-test losses.

4. The staff stated that it would be important to ensure that the debris pieces used for the erosion testing are exposed to representative flow conditions (e.g., velocity and turbulence). After reviewing results from Alion's computational fluid dynamics model of the erosion test flume configuration for the existing erosion testing, the staff was concerned that the lack of a fully developed velocity profile and low flume turbulence relative to plant containment pools could also be an issue for the proposed testing. In addition, the staff was concerned that Alion's placement of several sample racks in series in the test flume could further result in a "shadowing effect," by which upstream samples and sample racks would reduce the velocity and dampen the turbulence to which downstream samples would be exposed. Alion stated that the addition of a pre-filter to the test flume would help to reduce the velocity stratification apparent in the computational fluid dynamics results for the existing testing. Alion also stated that additional computational fluid dynamics modeling of the flume configuration for the planned testing was being performed to verify aspects of the turbulence modeling and demonstrate representative flow conditions for the planned testing. The staff suggested that Alion discuss the velocity and turbulence results from the additional computational fluid dynamics modeling with the staff prior to performing the planned erosion testing. The staff further suggested that Alion align the test debris pieces in a manner that would minimize the velocity and/or turbulence defect resulting from upstream samples "shadowing" downstream samples.

5. The staff stated that it was unclear whether the quantity of fines eroded from upstream samples and subsequently captured on downstream samples would be insignificant. Although Alion planned to consider the importance of this effect through statistical analysis, the staff was not confident that this approach would be successful due to the presence of additional variables that could also result in a discrepancy in the eroded mass for upstream and downstream samples, particularly the shadowing effect described above. The staff suggested that Alion attempt to align the test debris pieces in a manner that would simultaneously expose them to representative flow conditions (i.e., minimize shadowing) and minimize capture of fines from upstream pieces on downstream samples. If such an alignment were found to be impossible, this would indicate that the number of samples inserted in each test should be reduced.

6. The staff stated that new theories or methods used to refine the results for the planned testing should also be considered for their effect on the existing test data in order to understand the full data set. Specific discussion followed concerning Alion's plan to measure the dissolution of fiberglass in deionized water (the test fluid for the planned testing), and subtract out the corresponding mass of dissolved fiber when calculating a cumulative erosion percentage. The staff considered Alion's approach to be physically reasonable, but suggested that a sufficient number of dissolution data points applicable to the Alion test condition be used as a basis to determine a conservative dissolution percentage. The staff considered reducing uncertainties associated with the dissolution percentage to be particularly important because Alion expected the effect of dissolution

to be on the same order as that of erosion. Alion further stated that informal benchtop dissolution testing for fiberglass in tap water (the test fluid for the existing erosion testing) had been performed, which suggested that the dissolution of fiberglass fibers in tap water would be minimal. The staff considered the dissolution behavior of fiberglass in tap water to be of significance to understanding the behavior of the full set of erosion data. Specifically, an understanding of this dissolution behavior could form part of the basis to justify subtracting dissolution from the results of the planned tests in deionized water, while justifying that no correction need be applied to the existing tests in tap water.

7. The staff suggested that Alion consider the manner in which the test debris samples are held against the sample plates in the test flume. Ideally, the samples would be held against the sample plates in a manner that would prevent them from agglomerating or shielding each other, but not compress the samples in a manner that could non-prototypically inhibit erosion.

The staff also made two points of significance to licensees' application of the erosion testing. First, the staff stated that it would be considered a licensee responsibility to justify the application of Nukon low-density fiberglass test results to other types of low-density fiberglass that are significantly different than Nukon. Second, the staff considered the Alion test conditions to be applicable for simulating the erosion of fiberglass that has settled onto the containment pool floor using approved debris transport metrics. It is not clear to the staff that the planned Alion testing will address all plant-specific conditions under which erosion may be significant, such as the use of alternate analytical transport metrics that exceed the approved incipient tumbling velocity, for debris capture at curbs or interceptors, or for debris settlement during strainer head loss testing. Additional plant-specific analysis may be necessary for conditions such as these.

While noting the issues above, the staff was encouraged that Alion had made progress in addressing staff issues originally raised regarding the existing erosion testing. For instance, the staff noted that Alion had re-analyzed the existing test data in an attempt to better understand the results, revised aspects of the planned test setup and protocol to reduce or eliminate some of the uncertainties that may have affected the previous tests, and revised the theoretical discussion of erosion to be consistent with observations made based on the existing body of erosion data.

Staff Follow-Up Actions

- Review the velocity and turbulence results from the computational fluid dynamics model generated by Alion for the flume configuration that will be used for the planned erosion testing to ensure they are in the range of expected plant conditions.
- Follow up with Alion concerning the release of organic binder material during the boiling of the test debris pieces. Based upon information presented during the teleconference, it was not clear that the boiling procedure currently being implemented by Alion is capable of removing the organic binder to the extent it would be removed by long-term exposure to hot plant piping and high-temperature sump fluid. The staff expects that removal of additional binder would promote increased erosion.
- Follow up with Alion concerning the planned test schedule to support staff observation of part of the Alion erosion testing.

List of Teleconference Participants

Organization	Plant	Name
Alion Science & Technology	N/A	Craig Sellers
Alion Science & Technology	N/A	Gary Kaczynski
Alion Science & Technology	N/A	Gil Zigler
Alion Science & Technology	N/A	Jan Bostelman
Alion Science & Technology	N/A	Luke Bockewitz
Alion Science & Technology	N/A	Megan Stachowiak
Alion Science & Technology	N/A	Pete Mast
Alion Science & Technology	N/A	Tim Sande
Alion Science & Technology	N/A	William Knous
Constellation	Calvert Cliffs	Andre S Drake
Enercon Services, Inc.	Indian Point	David Dijak,
Enercon Services, Inc.	Indian Point	Eric Crabtree
Enercon Services, Inc.	Indian Point	Kip Walker
Entergy Operations Inc.	Indian Point	Jeff Gehrlein
Entergy Operations Inc.	Indian Point	Leland J Cerra
Entergy Operations Inc.	Indian Point	Roger Waters
Entergy Operations Inc.	Indian Point	Steve Munoz
Entergy Operations Inc.	Palisades	George Goralski
Entergy Operations Inc.	Palisades	Keith Smith
Entergy Operations Inc.	Waterford	Gregory N Ferguson
Florida Power & Light	St. Lucie / Turkey Point	Brian Dunn
Florida Power & Light	St. Lucie / Turkey Point	Loretta Cecilia
Luminant Generation Co., LLC	Comanche Peak	Charles K. Feist
Nuclear Energy Institute	N/A	John C. Butler
Omaha Public Power District	Fort Calhoun	Joseph K Gasper
Southern Nuclear Company	Vogtle	Dave Midlik
Southern Nuclear Company	Vogtle	Jimmy P. Cash
U.S. Nuclear Regulatory Commission	N/A	Chris Hott
U.S. Nuclear Regulatory Commission	N/A	John Lehning
U.S. Nuclear Regulatory Commission	N/A	Steve Smith
U.S. Nuclear Regulatory Commission	N/A	Stewart Bailey
Wolf Creek Nuclear Operating Corp.	Wolf Creek	Ronald W Holloway

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Enercon Services, Inc.	Indian Point	Kip Walker
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Entergy Operations Inc.	Indian Point	Leland J Cerra
Entergy Operations Inc.	Indian Point	Roger Waters
Entergy Operations Inc.	Indian Point	Steve Munoz
Entergy Operations Inc.	Palisades	George Goralski
Entergy Operations Inc.	Palisades	Keith Smith
Entergy Operations Inc.	Waterford	Gregory N Ferguson
Florida Power & Light	St. Lucie / Turkey Point	Brian Dunn
Florida Power & Light	St. Lucie / Turkey Point	Loretta Cecilia
Luminant Generation Co., LLC	Comanche Peak	Charles K. Feist
Nuclear Energy Institute	N/A	John C. Butler
Omaha Public Power District	Fort Calhoun	Joseph K Gasper
Southern Nuclear Company	Vogtle	Dave Midlik
Southern Nuclear Company	Vogtle	Jimmy P. Cash
U.S. Nuclear Regulatory Commission	N/A	Chris Hott
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