ALION
SCIENCE AND TECHNOLOGY

4525 Weaver Parkway, Suite 230
Warrenville, Illinois 60555
tel: 630.393.1215 fax: 630.393.1235
www.alionscience.com

March 28, 2008
261-4779-LTR-07

Mr. Michael L. Scott
Chief, Safety Issues Resolution Branch
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Mail Stop O-11A11
Washington, DC 20555-0001

Subject: Resolution of NRC Questions Regarding ALION VUEZ 30 Day Testing Program Status of Responses

Reference:
1. Alion Letter 261-4779-LTR-01, Dated February 8, 2008 entitled Resolution of NRC Questions Regarding ALION VUEZ 30 Day Testing Program Status of Responses.
2. NRC Questions – Alion Follow Up Issues – Corrected-Bolded, sent February 13, 2008.

Dear Mr. Scott:

As stated in the Reference 1 letter, the attached are our responses to Alion Problem Statement Nos. 5, 6, 11, 16 and 19. A table has been included indicating the status of each open item. The NRC comments and questions are taken from Reference 2.

Alion Problem Statement No. 5

Address the adequacy of the turbulence levels in the tank to ensure adequate circulation around all coupons/materials and material in suspension.

The following response encompasses NRC comment No. 10.

10. Alion should (a) procedurally document the extent of debris settlement in the tank for each test and the justification for any observed settling being acceptable and (b) demonstrate that reduced flow rates and the addition of sample baskets and coupons does not cause non-prototypical settling in the test tank.

Response:

The extent of debris settlement is incorporated into the test observations following each test in accord with the ALION Project Plan, ALION-PLN-ALION-1002-01. Copies of these observations are available upon request.

Prior to starting the Vuez chemical effects head loss testing, Alion performed preliminary tests intended to investigate flow patterns inside the Vuez loops as a function of the loop flow rate. This testing focused on observing the transport of small pieces of fiber for a range of test loop flow rates in order to identify the minimum test loop flow rate above which fibers were in a continuous motion and therefore no stagnant regions within the tank fluid volume were created. This testing concluded that test loop flow rates greater than 0.5 L/min prevented the creation of stagnant regions within the tank fluid volume. As a result of these observations Alion's Vuez chemical effects head loss tests were conducted with test loop flow rates greater than 0.7 L/min. Test loop flow rates greater than 0.7 L/min ensured (based on fiber transport observations) that adequate fluid flow was developed among the various submerged coupons and baskets.

During the conduct of testing the following was observed:

a. The fluid flow would carry away fibers from the submerged baskets which eventually settled on the tank floor.
b. Particulate material such as silicon carbide and silica sand in the fiber bed would be carried away by the fluid (due to insufficient fiber to capture all the particulate). Most of this particulate material would settle in the chimney part of the test tank, however, a small fraction was carried by the flow and was discharged into the test tank and eventually settle on the test tank floor.
c. At the conclusion of the tests, samples of the materials that had settled on the tank floor were collected and analyzed to identify their consistency.

Prior to the start of Vuez testing, Alion performed extensive bench-top testing with appropriately scaled materials to simulate the chemical effects of the plant containments tested at Vuez. The bench-top tests did not observe the formation of any chemical effects products that precipitated in the test beakers.

Based on the Vuez test and bench-top test observations, Alion determined that the material on the Vuez test tank floor consisted of silicon carbide and silica sand (surrogate material added to the debris bed). The flow rates used during testing and the addition of sample baskets and coupons does not cause non-prototypical settling in the test tank and is representative of expected plant conditions

Alion Problem Statement No. 6

Address any material settling inside the tank and its effects on the results.

The following response encompasses NRC comment Nos. 20 and 21.

20. Alion should demonstrate that, for coupons and debris baskets that are only in the test tank for a discrete period of time, the potential for slow or non-uniform mixing of the test fluid and the potential for unevenly mixed chemical constituents does not have a non-conservative impact on the corrosion/degradation of the coupons and debris baskets, which are assumed to be in contact with well-mixed test fluid for the entire period of immersion.

21. In light of the staff observations of debris densely packed into baskets, debris baskets with only one open side, and debris baskets and samples being tightly spaced in the test tank, Alion should demonstrate that the test tank fluid at VUEZ can interact with the materials in the tank in a representative manner.

Response:

These are not fast acting chemical agents and it does take time for some chemical materials to form true solutions. When initially mixed, the buffering agent is truly a suspension, similar to chemical precipitates. Addition of a suspension to the test loop has the same effect as adding chemical precipitate, an increase in head loss. For one test, conducted at the Warrenville Laboratory, Sodium Tetra borate was circulated, after adding as a powder, for 24 hours to ensure we had a homogeneous mixture. If the buffers are being added as powders, then the same effect will occur. For short duration test materials, ex-test loop mixing was performed to ensure that the chemicals were fully dissolved into solution. Slow or non-uniform mixing is representative of post-LOCA conditions. As stated, to be conservative, pre-mixing was performed.

The test tank fluid does interact with the materials in a representative manner. Based on the Alion scaling methodology, the contact time in the test tank will be very close to the actual conditions. Internal localized flow patterns and eddies were modeled to match containment configurations and conditions. Test tank flow conditions, turbulence, flow rates etc were also modeled and matched to represent actual containment flow configurations and conditions. The result was contact times representative of plant conditions.

Prior to running the tests, minimum flow rates were studied to preclude the development of stagnant regions. The studies concluded that test loop flow rates greater than 0.5 L/min prevented the creation of stagnant regions within the tank fluid volume. As a result of these observations Alion's Vuez chemical effects head loss tests were conducted with test loop flow rates greater than 0.7 L/min. Test loop flow rates greater than 0.7 L/min ensured (based on fiber transport observations) that adequate fluid flow was developed among the various submerged coupons and baskets. However, it is recognized that in any complex test loop geometry, there may be dead areas. Understanding this, the test coupons were separated by spacers allowing free flow and full circulation on all sides. Also, following the NRC Staff visit, the basket configuration was changed to allow full flow through and around the baskets. The test configurations with densely packed materials, complex geometries, flow patterns, etc are holistically representative of actual conditions. Recall that the stated purposes of the Vuez tests were to simulate the generation of chemical precipitates and their impact on head loss; to understand changes, not to show and explicitly determine absolute values.

Like an actual containment or low flow situations, heavy or non-neutrally buoyant materials will settle and not necessarily fully interact with all process constituents. The tests did note the settlement of heavy particles. The material that settled on the floor of the test tank was observed to be silicone carbide and silica sand. Alion's bench-top tests did not observe the formation of any chemical effects products that precipitated in the test beakers and since silicone carbide and silica sand are chemically inactive, it is concluded that the material settling inside the tank does not affect the chemical effects head loss testing

Alion Problem Statement No. 11

What is the impact of a sudden temperature drop from a heat exchanger and the potential for thermal cycling?

The following response encompasses NRC comment No. 16

16. Alion should (a) describe the impact of thermal cycling of the test fluid to represent a sudden temperature drop in a heat exchanger and (b) demonstrate that neglecting this effect does not have a significant adverse impact on the VUEZ test results.

Response:

Typical power plant design has the system heat exchangers downstream of the system pump. For ECCS or CSS operation flow then proceeds either through the containment spray nozzles to the containment atmosphere. The path through ECCS is torturous as well. The fully turbulent flow will pass through long runs of pipe, throttle valves, orifices and other piping components eventually reaching the reactor core. One it reaches the core the post-LOCA fluid will then pick up heat. Thermal cycling occurs downstream of the sump screen. Evaluation of throttle valves and the reactor core are outside the scope of the VUEZ testing.

Regardless, one can assume a nominal 50 F drop across a typical RHR heat exchanger. The expected impact of a sudden temperature drop from a heat exchanger and the potential of thermal cycling for the following distinct containment post LOCA time periods can be addressed by considering the following two cases:

a. Time period during which the sump temperature is higher than 190 °F and

b. Time period during which the sump temperature is lower than 190 ˚F

During the time period that the sump temperature is higher than 190 ˚F, a sudden temperature drop would reduce the chemical effects release rate (release rate is proportional to temperature per the Arrhenius theory) and therefore such a temperature drop would reduce the formation of chemical effects products in the sump fluid that would be available to precipitate at lower temperatures and contribute to the chemical effects head loss.

During the time period that the sump temperature is lower than 190 ˚F, a sudden temperature drop would increase the quantity of chemical effects by products that reach their saturation temperature and precipitate thereby increasing the chemical effects head loss. A sudden increase in temperature during this time period would have the opposite effect in that it would tend to dissolve the precipitate material back in the fluid thereby decreasing the chemical effects head loss.

Therefore, sudden drops in temperature occurring early into the event would tend to reduce the generation of chemical effects products and the impact on head loss while sudden drop in temperature occurring later into the event would tend to increase quantity of precipitates and their impact on chemical effects head loss.

The likely hood of extreme temperature excursions is more probable during the early stages of the event. As explained earlier, not considering temperature in the testing, allows the early pressure drop to be maximized. Later in the accident, extreme temperature changes are both less likely and considerably smaller. The plant conditions needed to create low, extreme temperature changes are also less clear. Therefore neglecting extreme temperature changes early is conservative, neglecting them later is reasonable. There are no impacts on the Vuez testing or results due to not modeling extreme temperature changes.

Alion Problem Statement No. 16

How are measurement uncertainties accounted for in the development of the test parameters and application of the experimental results?

The following response encompasses NRC comment No. 25

25. Alion should demonstrate that neglecting measurement uncertainties associated with the VUEZ testing does not have a significant adverse impact on the validity of the test results.

Response:

The Vuez Facility testing was intended to determine the change in head loss associated with a specified condition (precipitate, temperature, etc). The intent of the testing was not to determine the absolute head loss associated with a given debris mix and chemical interaction. The use of accurate instruments, calibrated to accepted standards, to monitor test parameters is reasonable and appropriate.

Alion did not neglect measurement uncertainties in the development of the test facility or protocols. Critical test parameters were measured with instrumentation calibrated to accepted standards. No uncertainty analysis was performed or deemed necessary. We fully understand the concepts involving variances of independent random variables being additive, but applying them to this test protocol was not necessary or reasonable.

The test protocols were generally developed or based on conservatively bounding inputs from each of the plants. It is noted that each parameter measured or controlled is not entirely or necessarily dependent on one or all of the other parameters. The result of quality, calibrated instruments with conservative inputs is a test that produces reasonably conservative or nominal results. This was the stated intent. The nominal instrument uncertainty is more than offset by the conservatisms in the debris mix. The result of artificial addition of test uncertainty on top of conservative inputs is an unreasonable test with no basis or connection to plant conditions. Therefore, it was concluded that an uncertainty analysis was not necessary and that the use of instruments calibrated to accepted standards is reasonable and would not have a significant impact on the validity of the test results.

Alion Problem Statement No. 19

Provide a summary of the quality assurance issues noted and their impact on results or corrective actions taken?

The following response encompasses NRC comment No. 28

28. Alion should demonstrate that the quality assurance associated with the VUEZ testing is adequate.

Response:

Alion takes very seriously the quality aspects of the experiment as well as all aspects of our work. Alion maintains a 10CFR50 Appendix B Program. The Vuez work was performed in accord with ALION-PLN-ALION-1002-01. When, errors or non-conformances occur they are identified and appropriate corrective actions taken. The Alion program is available for staff review upon request.

During the staff visit to the Vuez Facility, they noted that a procedure required that boiled Temp-Mat be added to the tank; however, the Temp-Mat that was added to the tank did not appear to the staff to have been boiled. After significant parts of 2 of the 4 formed debris beds floated away, the vendor then stated that it was not clear that the Temp-Mat had been boiled and attributed the partial floatation of the two debris beds to the Temp-Mat not having been boiled. Further investigation by Alion staff showed that the Temp-mat was indeed boiled. However, to eliminate any questions as to the validity of the test, the test was re-performed with new material prepared as required. This observation was noted in the project notes.

Also, during one of the tests that was nearly completed the staff observed a sample material basket that had been resting screen-side down (presumably for the duration of the test), such that no basket surfaces were open for fluid interaction with the test fluid. As a result, no leached material from the debris samples in this sample basket could have participated in the test. As a result of this event Alion implemented a wire mesh container for the submerged materials to preclude any inadvertent orientation changes and to promote better circulation of the fluid through the materials. A discussion of this observation and resulting corrective actions are detailed in the Vuez Project notes.

As stated, Alion takes very seriously the quality aspects of the experiment as well as all aspects of our work. Alion maintains a 10CFR50 Appendix B Program. The Vuez work was performed in accord with it and it's project plan. When, errors or non-conformances occur they are identified and appropriate corrective actions taken. The Alion program is available for staff review upon request. Alion, VUEZ and licensee oversight has ensured that test startups have gone according to both the technical and quality requirements. Non-conformances are identified, documented, dispositioned, corrective actions taken and communicated to Alion and their clients for acceptance. Based upon these actions, the testing at the Vuez Facility is adequate and in accord with 10CFR50 Appendix B.

If you have any questions or require additional information please contact me at (630) 846-6787 or Steven Unikewicz at (703) 439-7133.

Sincerely,

Robert Choromokos
Manager, Energy Services Division

cc: P. Mast
S. Unikewicz
Owner's Group Distribution

Table 1: ALION VUEZ CE Testing Questions

No.	NRC Issue/Comment	No.	ALION Problem Statement	Completion Date	Status
1 3 4	Prototypicality of poured debris bed Prototypicality of poured debris bed Representativeness of debris size distribution	1	Provide the basis for the debris bed preparation, including the size characteristics and method of formation relative to the prototype debris bed.	March 10, 2008	LTR-04
5 6	Maximum load versus thin-bed testing Maximum load versus thin-bed testing	2	How are the chemical effects captured for the range of debris loadings possible in the plant specific analysis given the impact of chemical effects could be different for different debris loading conditions?	Feb 15 2008	LTR-02
7	Flat plate representative of filled strainer volumes	3	Why is the debris bed on a flat plate representative of a debris bed on a complex shape and filled strainer volumes?	Feb 15 2008	LTR-02
9	Bypass flow around bed - edge effects	4	Describe the impact of the VUEZ screen configuration and suction piping on the results. The screen may exhibit bypass flow at the edges of the debris bed. How is this prevented or considered in the results?	March 10, 2008	LTR-04
10	Debris settling in tanks	5	Address the adequacy of the turbulence levels in the tank to ensure adequate circulation around all coupons/materials and material in suspension.	March 28, 2008	
21 20	Flow conditions and material interaction Tank mixing versus time of material interaction	6	Address any material settling inside the tank and the impact on the results.	March 28, 2008	
8	Gas void issues and impact on results	7	Describe the impact of gas void issues under the debris bed on the results.	April 4, 2008	
2	Technical basis of bump-up factor	8	Provide the basis for the bump up factor and illustrate with an example.	Mar 24, 2008	LTR-06

Table 1: ALION VUEZ CE Testing Questions (cont'd)

No.	NRC Issue/Comment	No.	ALION Problem Statement	Completion Date	Status
11 12 13 14 18	Test parameters ensure a conservative test Basis for temperature correction Basis for timing of acid addition Basis for timing of LiOH addition pH shock and impact on head loss	9	Provide the basis for the selection of the time, temperature, chemistry and materials used for the test to ensure a conservative test is performed with respect to plant conditions.	Feb 15, 2008	LTR-02
15	Impact of elevated pH due to debris in DM water	10	What is the impact of the elevated pH due to debris dissolution in demineralized water on the results of the experiment?	April 4, 2008	
16	Impact of sudden temperature drop in HX	11	What is the impact of a sudden temperature drop from a heat exchanger and the potential for thermal cycling?	March 28, 2008	
17	Representativenss of plate for failed metallic coatings	12	What is the basis for representing failed metallic coatings as metallic sheets?	Feb 22 ,2008	LTR-03
19	Inclusion of fiberglass binder in experiment	13	What is the impact of neglecting the fiberglass binder in the experiment?	March 7, 2008	LTR-05
22 23	Volume change due to material additions Effect of sampling on chemical concentrations	14	What is the impact of fluid sampling on the experiment?	March 7, 2008	LTR-05
24	Repeatability of tests	15	Are the tests repeatable?	Feb 15, 2008	LTR-02
25	Measurement uncertainties	16	How are measurement uncertainties accounted for in the development of the test parameters and application of the experimental results.	Mar 28, 2008	
26	Copy of test procedure for large Elisa Loop	17	Provide a copy of the large loop test procedure.	Feb 15 2008	LTR-02
27	Copy of alkyd coatings chemical report	18	Provide a copy of the alkyd coatings chemical report?	Feb 15 2008	LTR-02
28	Quality assurance	19	Provide a summary of any quality assurance issues noted and their impact on results or corrective actions taken.	Mar 28 2008	