**RAI 7**

The staff requested additional information on the size distribution of fibrous debris used during testing and requested that the licensee provide information that justified the fibrous debris used during testing. The licensee stated that small fines were used. However, the staff guidance requests that the fibrous debris sizing be further broken down into small and fine debris categories. Current staff guidance states that thin bed testing should be conducted with only fine (easily suspendable) fiber (until all predicted fine fibers have been added to the test). The licensee response to the RAI did not address the referenced guidance. It is possible, but unlikely, that a thin bed test conducted in accordance with the latest guidance could result in higher head losses than were attained during the TMI-1 testing. It is more likely that the full load test, if conducted with prototypically sized fiber could have resulted in higher head losses. The licensee should provide information that justifies that the head losses attained during testing were not influenced non-conservatively by the sizing of the fibrous debris used during testing.

**Response Summary:**

The NRC Staff guidance provided in March 2008 indicated that the use of excessively coarse fibrous debris in testing will likely result in non-conservative results. Compared to the debris size distributions assumed in the TMI-1 debris analyses, the test debris preparation procedure resulted in debris sizes that were biased toward the smaller debris size classes. Test photographs and records provide evidence that the material transported to the strainers was not excessively coarse. Therefore, it is concluded that the TMI-1 test results were not influenced non-conservatively by the sizing of the fibrous debris used during testing.

Although the TMI-1 strainer tests were conducted prior to the March 2008 guidance, the extensive test program conducted by TMI-1 demonstrated that the thin bed head losses are not controlling for the TMI-1 strainer design. The test preparation procedure and test methodology utilized for TMI-1 testing did result in covering the strainer with a mat of fine fibers as shown in the photographs provided below. In all cases, the head losses for the thinner beds were less than the head losses measured for the full load tests.

**Response Details:**

I. Discussion of Full Load Test:

I.A Discussion of Low-Density Fiberglass Insulation (LDFG) Debris Size Distribution Assumed in the Debris Analyses:

As noted in Table 2 of the GL 2004-02 SR, the debris size distribution for NUKON assumed in the TMI-1 debris analysis included small-fines and large pieces. The TMI-1 analysis definition of “small-fines” is consistent with NEI 04-07 Baseline Guidance which is fibers and small pieces of sufficient size to pass through grating and readily transport. The division between the small-fines and large pieces is nominally 4”. Regarding the further classification and size distribution of “small-fines”, there is no specific definition or guidance in either NEI 04-07, associated SER or the NRC March 2008 Supplemental Guidance. However, Appendix II, Section II.3.1.1 of the NEI 04-07 SER states, “In the debris generation tests conducted during the Drywel Debris Transport Study, 15 to 25 percent of the debris from a completely disintegrated Transco

Products, Inc. fiberglass blanket was classified as nonrecovereable. The nonrecovereable debris either exited the test chamber through a fine-mesh catch screen or deposited onto surfaces in such a fine form that it could not be collected by hand (it was collected by hosing off the surfaces). Therefore, it would be reasonable to assume that 25 percent of the baseline small fine debris is in the form of individual fibers and the other 75 percent is in the form of small-piece debris."

Historically, small-fines have been considered to be Class 1 though 6 as described in NUREG/CR-6224 (see Table 3-2 below). Based on the assumed size definition of less than 4" nominally, Classes 1 though 6 represent "small-fines." For illustration, Class 5 debris is shown in Figure 7-1 and represents fiberglass fragments that are defined as "transportable" as they tumble and slide along the floor.

**Table 3-2 Size Classification Scheme for Fibrous Debris[3-2]**

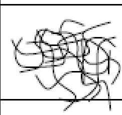
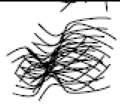
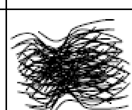
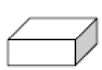
| No. | Description | |
|---|---|---|
| 1 |  | Very small pieces of fiberglass material; "microscopic" fines that appear to be cylinders of varying L/D. |
| 2 |  | Single, flexible strands of fiberglass; essentially acts as a suspending strand. |
| 3 |  | Multiple attached or interwoven strands that exhibit considerable flexibility and that, because of random orientations induced by turbulent drag, can exhibit low settling velocities. |
| 4 |  | Fiber clusters that have more rigidity than Class 3 debris and that react to drag forces as a semi-rigid body. |
| 5 |  | Clumps of fibrous debris that have been noted to sink when saturated with water. Generated by different methods by various researchers but easily created by manual shredding of fiber matting. |
| 6 |  | Larger clumps of fibers lying between Classes 5 and 7. |
| 7 |  | Fragments of fiber that retain some aspects of the original rectangular construction of the fiber matting. Typically precut pieces of a large blanket to simulate moderate-size segments of original blanket. |

Figure 7-1

Fiberglass shreds in size Class 5

I.B Discussion of Prepared LDFG Debris Size Distribution for Testing:

The Alion debris preparation procedure used for all TMI-1 prototype tank testing, including the November 2007 test of record, was designed to produce "small-fine" debris of Classes 1 through 4, finer than that required by NEI 04-07 (i.e., no pieces in classes 5 through 7 or 4" debris). The following fiber preparation steps are excerpted from the procedure:

3.0 PROCEDURE (Fiber Preparation)

3.1 This section is used to prepare low density fibrous insulation to be used for testing in the vertical test loop or large flume. These low density fibrous insulations include, but are not limited to NUKON, MINERAL WOOL, and THERMAL-WRAP.

3.1.1 Prepare the insulation material for the shredder by cutting it into 12" square pieces. Note: If material was procured in a shredded form, skip to step 3.1.4[1].

3.1.2 Process the insulation material through a shredder. If only a small amount of material is required, it is acceptable to shred the insulation by hand.

3.1.3 Collect the shredded insulation.

3.1.4 Using a representative sample of the shredded insulation, compare the size distribution of shredded insulation with that identified in NUREG/CR-6808, Table 3-2, "Size Classification scheme for Fibrous Debris", or NEA/CSNI/R (95)11, Table 3.1, "Fibrous Debris Classification' and Figure 3.1, "Examples of Fibrous Debris Fragments Tested". The desired size classification would be Numbers 1 through 4. Refer to Appendix 1 of this document.

3.1.5 If all of the shredded insulation, or a portion of all of the shredded insulation is too large compared to the classifications of Table 3-2 in NUREG/CR-6808, or Table 3.1 of NEA/CSNI/R (95)11, then process the large pieces of insulation through the shredder or shred by hand.

3.1.6 Using a representative sample of the shredded insulation, compare the size distribution of shredded insulation with that identified in the previously referenced Tables. The desired size classification would be Numbers 1 through 4.

3.1.7 Repeat the insulation shredding as needed to achieve the desired quantity and size distribution of insulation to be used for the testing as required by the Test Plan.

3.1.8 Shredded insulation that does not satisfy the desired size distribution should be removed from the insulation sample and discarded per the MSDS or the ALION Science & Technology Environmental Health and Safety Manual.

3.1.9 Weigh out the required quantity of processed insulation for testing that meets the desired size distribution as required by the Test Plan.

[1] All TMI-1 fibrous debris was procured in bulk form (i.e., not shredded).

3.1.10 If the insulation is new (i.e., not aged) use one of the following methods as required by the Test Plan or as directed by the Test Engineer.
Method 1: boil the insulation for 60 minutes. (Note: boiling insulation for 60 minutes is part of the debris preparation methodology adopted by the NRC for use at the UNM vertical loop testing facility.)

Method 2: boil the insulation for 5 minutes. (Note: boiling insulation for 5 minutes is part of the debris preparation methodology adopted by LANL for use at the LANL vertical loop testing facility.) *{Note that this method was used for TMI-1.}*

3.1.11 Put the insulation in a bucket of water at a temperature within ± 10 ˚F of the temperature of the water to be used in the testing.

3.1.12 Mix / beat the insulation with paint mixer attached to an electric drill for five minutes or until a homogeneous slurry is formed.

3.1.13 The insulation is now ready for testing.

I.C Comparison of Prepared Test Debris to Debris Analysis Assumptions:

Although the prototype testing for TMI-1 was performed prior to the March 2008 Supplemental Guidance, the debris size distribution established by the debris preparation procedure for the head loss testing was consistent and conservative with respect to the TMI-1 debris generation and transport analysis per the definition of “small-fines”. The analyses definition consider small fines to include Classes 1 through 6 whereas the debris preparation procedure produces Classes 1 through 4. It should be pointed out that all of this debris is considered “transportable”. Therefore, with respect to the debris size distribution, the analysis and the testing definitions are conservative and in alignment.

II. Discussion of Thin Bed Test:

RAI #7 recommends and points out that, “Current staff guidance states that thin-bed testing should be conducted with only fine (easily suspendable) fiber (until all predicted fine fibers have been added to the test).” This recommendation came after TMI-1 had already completed the debris head loss testing and on the surface would suggest that all individual fibers can arrive solely to the strainer and create a unique condition that causes a limiting head loss - in the presence of the full particulate loading - without any other sizes of debris. This fine fiber only arriving first represents an unrealistic scenario and poses a significant challenge to the test facility as it is practically impossible to manufacture only “fine” debris (there has been considerable discussion on this definition and methods to achieve this size debris). A more plausible or realistic condition would be that settling of small pieces does occur (over the conservative predictions of the transport analysis) such that only fines accumulated on the sump screen. Recall the previous discussion regarding the distribution of small-fines could be considered to be 25% fines and 75% small pieces. This scenario is not only realistic, but one that often occurs in the test facility during debris testing.

The testing of the TMI-1 prototype screen with Class 1 though 4 fibers at Alion was performed for both the thin and thick bed testing for TMI-1. The protocol made no attempt to segregate individual fibers through sieving or other means from the debris mixture, as this was impractical.

The testing involved a series of tests with debris quantities that would produce from 1/8" up to 2.43" debris bed thicknesses. Although the test protocol was designed to encourage debris deposition on the screen through tank turbulence (stirring and trolling motors), this was not always successful in the earlier tests, as was witnessed on one of the NRC visits.

The following table presents all of the TMI-1 prototype testing sequences. The November 2006 test series did not include chemical effects. The data provided below for the 2007 tests was recorded after stabilization of the fiber and particulate debris bed but before addition of the WCAP predicted precipitates. The November 2007 Test 2B is the current design basis loading case.

**Draft- All data is PRELIMINARY**

| Test | Date | Bed Thickness | Head Loss (@85F) | Debris Volume | Reference |
|---|---|---|---|---|---|
| 4 | Nov-2006 | 0.1" | 0.22' | Latent Only | -10 |
| 1 | Nov-2006 | 3/8" | 0.22' | | -10 |
| 3 | Nov-2006 | 1.3" | 0.36' | 250 ft3 | -10 |
| 2B | Nov-2006 | 2.03" | 2.51' | 388 ft3 | -10 |
| 2C | Nov-2006 | 2.43" | 5.98' | 465 ft3 | -10 |
| | | | | | |
| 1B | Mar-2007* | 1.4" | 0.4' | 269 ft3 | -12 |
| 2B | Nov-2007 | 1.1" | 1.7' | 218 ft3 | -12 |

*NRC Witness

It should be pointed out that the NRC did witness the 2007 Test 1B. This is documented in the June 12, 2007 Trip Report. This Report by the Staff indicated that considerable settling did occur of the small pieces in Test 1B. As a result of this report, Alion implemented an additional attention to "agitation" in the Nov-2007 testing to facilitate transport to the sump screen. The differences in settling between the two tests are illustrated in the response to RAI #13. Review of the earlier 2006 tests indicates that as with the March 2007 testing, considerable sedimentation of the small debris pieces (as opposed to the smaller fines) also occurred in these tests. As a result of this preferential sedimentation of the small debris fragments from within the "small-fine" debris used for the testing, the debris actually reaching the screen tended to be comprised predominantly of "fine" debris. This is consistent with the conditions suggested by the NRC in their supplemental guidance.

Review of the 2006 Test 1, 3, 4 and 2007 Test 1B indicates that under a variety of load conditions, the screen design is not susceptible to thin-bed effects as has been Alion's experienced with this screen design. This is due to the non-uniform approach velocity and debris deposition. The Mar-2007 1B testing, as well as the earlier 2006 testing, did notice considerable debris settling of small pieces; however, the screen was completely covered in fines, which is a realistic scenario to produce a thin-bed effect considering some settling of small pieces. In all four cases involving small debris quantities with sedimentation of the larger "small/fine" debris fragments (2006 tests 1, 3, and 4 and 2007 test 1B), the thin-bed head loss is consistently much lower than the limiting load cases head losses, from which one can conclude that the thin-bed does not produce limiting head losses. In particular, 2006 Test 3 and 2007 1B produced essentially identical results, and both tests were completely covered in "fines." The following photographs were taken following draindown after the NRC witnessed 2006 Test 1B. Note the uniform deposition and fineness of the debris at the screen surface in Photo #3.

Photograph #1:  2007 Test 1B

Photograph #2:  2007 Test 1B

Photograph #3:  2007 Test 1B

Photograph #4:  2007 Test 1B

The maximum debris load is Test 2B (1.1"), which represents the design full load. This is the latest test and incorporated the Staff's feedback on non-prototypical settling in the earlier tests identified in the trip report. Alion implemented additional measures (stirring and trolling motor) to ensure transport to the test screen. The increased agitation and attention to settling produced a head loss consistent with the thicker debris loads from the earlier tests (2006 2B & 2C) and provide a limiting head loss. For this reason, it can be concluded from the head losses produced by the Alion testing that the thin-bed head losses are not controlling in this strainer design, and the maximum or full load debris head loss test is the controlling or limiting loading condition.

**RAI 11**

The staff requested additional information on whether containment overpressure was credited for the strainer flashing evaluation. The licensee provided additional information in this area, but it seemed that the question was not understood. The licensee evaluated flashing at the pump suction, but did not address potential flashing in the debris bed or within the strainer. Flashing within the strainer or debris bed can result in additional head losses. The licensee should verify that the potential for flashing at the strainer has been evaluated or provide the parameters such that the staff can verify that flashing will not occur. The minimum margin to flashing at the strainer should be provided. For example, provide strainer submergence, sump temperature, and strainer head loss as a function of time. If required, provide the minimum available containment pressure at the evaluated times.

**Response Summary:**

An analysis (currently draft) has been performed to evaluate the potential for flashing within the debris bed. The analysis concludes that flashing does not occur at the debris bed. The analysis does not take into account any containment overpressure (pressure over the initial containment pressure).

**Response Details:**

An illustration of the TMI-1 strainer is provided in Figure 11-1. The minimum water level is at elevation 283.9' and the top of the strainer top hat is at elevation 282.6' which provides approximately 1.3' of submergence to the top of the strainer top hat. As shown in the figure, the Emergency Core Coolant System (ECCS) pump suction inlet centerline is at elevation 275'-3" which provides approximately 8.5' submergence. Given the orientation of the vertical top hat strainer at TMI-1, flashing within the strainer at the debris bed due to potentially minimum submergence would, if it occurred at all, occur at the top of the strainers first. Therefore, the flashing analysis evaluates hydraulic conditions at the upper top hat elevation.

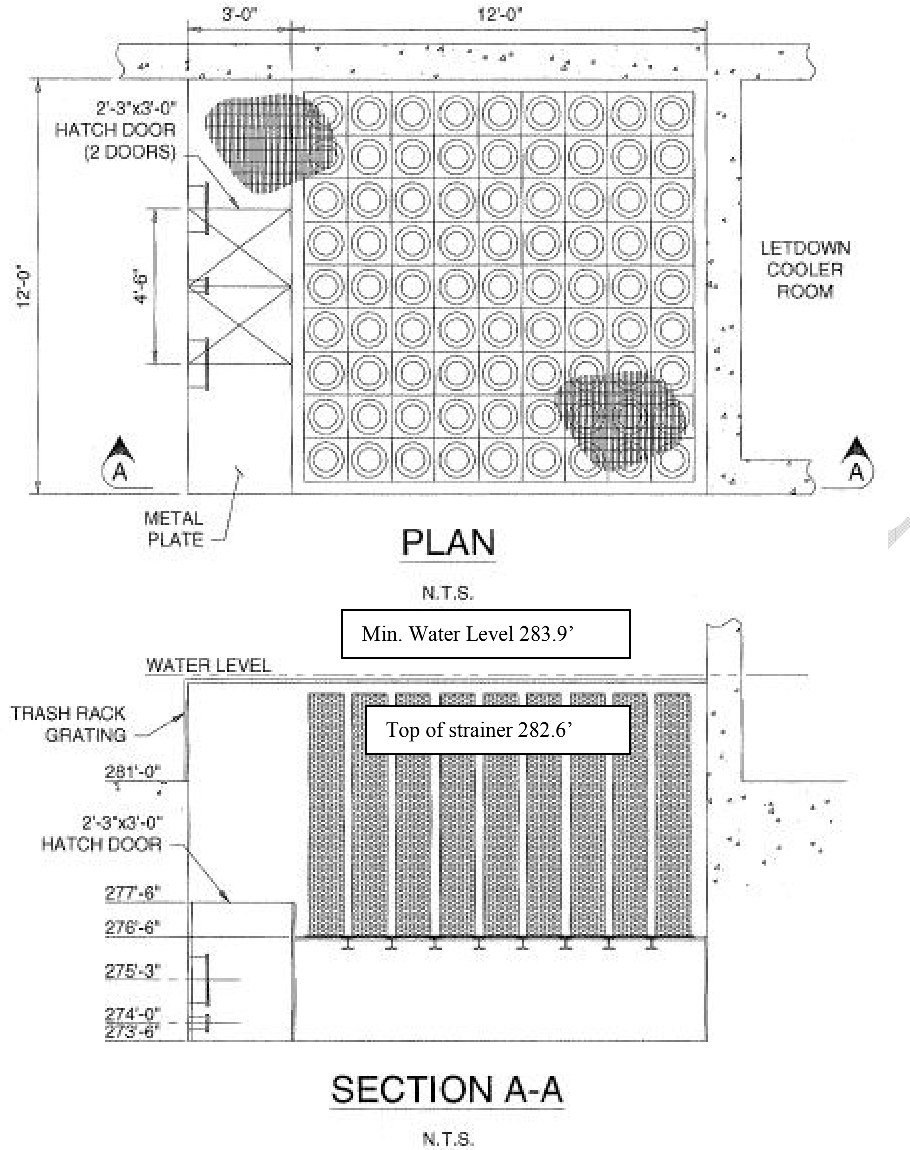



Figure 11-1: TMI-1 Containment Sump Configuration

In evaluating this information relative to the potential for flashing, the following criteria are considered:

a) If the submergence is greater than the debris head loss, then the fluid pressure within the debris bed is greater than the fluid pressure at the pool surface ( the containment pressure) and clearly no flashing within the debris will occur, or

b) If the submergence is less than the debris head loss, the potential for flashing within the debris bed does exist. To determine whether or not flashing does actually occur, one must calculate the fluid pressure on the inside of the strainer surface (containment pressure + submergence – debris head loss) and compare this to the fluid vapor pressure. If the vapor pressure is greater than this calculated fluid pressure, flashing would occur without overpressure. If the fluid pressure is greater than the vapor pressure, no flashing occurs.

The preliminary analysis results show that there is no potential for flashing until the pool reaches a temperature of 140 deg F (when chemical effects become significant), as prior to this time the debris head loss is less than the minimum strainer submergence. At temperatures colder than 140 deg F, the maximum head loss is well in excess of the minimum submergence. However, using the formula for fluid pressure noted above, the minimum fluid pressure within the debris bed at the top of strainer is well above the vapor pressure below 140 deg F. Therefore flashing of the fluid at the debris bed will not occur. This analysis does not take into account any containment overpressure (pressure over the initial containment pressure).

**RAI 13**

The staff requested justification for why the settlement that occurred during integrated chemical effects testing did not result in non-conservative head loss values. The licensee stated that multiple attempts were made to re-entrain settled debris into the test flume. The staff was present at a test of the TMI-1 strainers. During the test, the staff noted non-prototypical settlement of both chemical and non-chemical debris in the test tank. The trip report reference may be found at ADAMS Accession No. ML071230203. As noted in the trip report, the test tank geometry was significantly less conducive to transport than actual plant conditions. The trip report noted that the effects of debris settling should be addressed during the evaluation of the testing. The licensee should evaluate the effects of the settling on the test results.

**Response Summary:**

The Staff observed head loss testing that was performed for TMI-1 in March of 2007 and noted non-prototypical settling of chemical and non-chemical debris in the test tank. Improvements were made to both the test tank configuration and test procedures prior to the test of record for TMI-1 which occurred in November 2007. Although some minor settling did occur in the November test, the settling is not considered to be non-prototypical and did not significantly affect the test results.

**Response Details:**

**Background**

NRC representatives were present at the initial TMI-1 chemical strainer test performed at Alion in March 2007. This test was an early implementation of the prototype strainer array tests that utilize both physical (fiber/particulate/dirt/dust) and chemical precipitate debris. During this test, it was observed that significant quantities of debris settled on the floor of the test tank. Subsequent to this test, the design basis (full load) test was performed in November 2007 that was not witnesses by the NRC and incorporated enhanced methods to agitate the tank throughout the testing process. These methods proved effective in reducing the quantity of settled debris. The TMI-1 response to GSI 191 was based on the results from the November 2007 test.

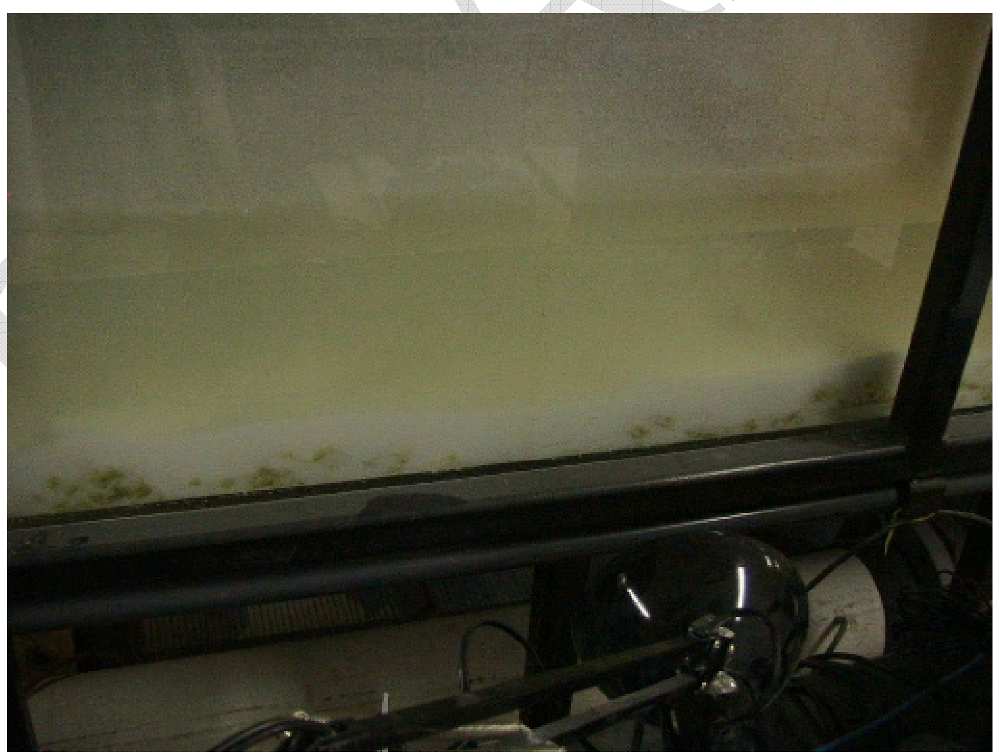
**Discussions**

March 2007 Testing

The initial test performed in March 2007 utilized a standard test tank configuration. Top hats were mounted vertically on the discharge base plenum to reflect the TMI-1 sump strainer orientation. A plywood box structure was installed around the top hat array to simulate the TMI-1 sump pit. The box structure included three “full height” walls that extended above the top of the prototype top hats, and one partial height wall to facilitate the transfer of debris on to the strainers. Flow through the array was discharged from the base plenum and returned to the tank through a flow diffuser to provide a degree of debris mixing. The diffuser used in this test was barrel shaped, approximately 24” diameter and 36” tall with an array of 2” diameter holes to diffuse the supply water in multiple directions. The diffuser was located near an outer tank wall, away from the plywood box structure to ensure that the discharge from the diffuser did not disturb the debris as it accumulated on the strainer surfaces.

The test configuration previously used in Alion Tests employed top hat arrays consisting of 9 total top hats (3 x 3 array). However, in order to accommodate the volume of chemical precipitates introduced to the tank in the March 2007 test, the array size was reduced to utilize a total of 4 top hats (2 x 2 array). This required a lower overall test flow rate to maintain the proper approach velocity at the strainer surface. For the 2 x 2 array, flow was reduced to 44% of the rate associated with the 3 x 3 arrays previously tested. This greatly reduced the effectiveness of the standard diffuser and allowed for the accumulation of settled physical and chemical debris on the floor of the test tank. Manual agitations of the tank were also not effective in suspending the settled debris sufficiently. Photographs 1 and 2 show the settled debris visible in the tank at the end of the March 2007 testing.

Photograph 1 – Settled Debris from TMI-1 Test Conducted 3/07 (southwest corner)



Photograph 2 – Settled debris from TMI-1 Test Conducted 3/07 (front edge)

November 2007 Testing

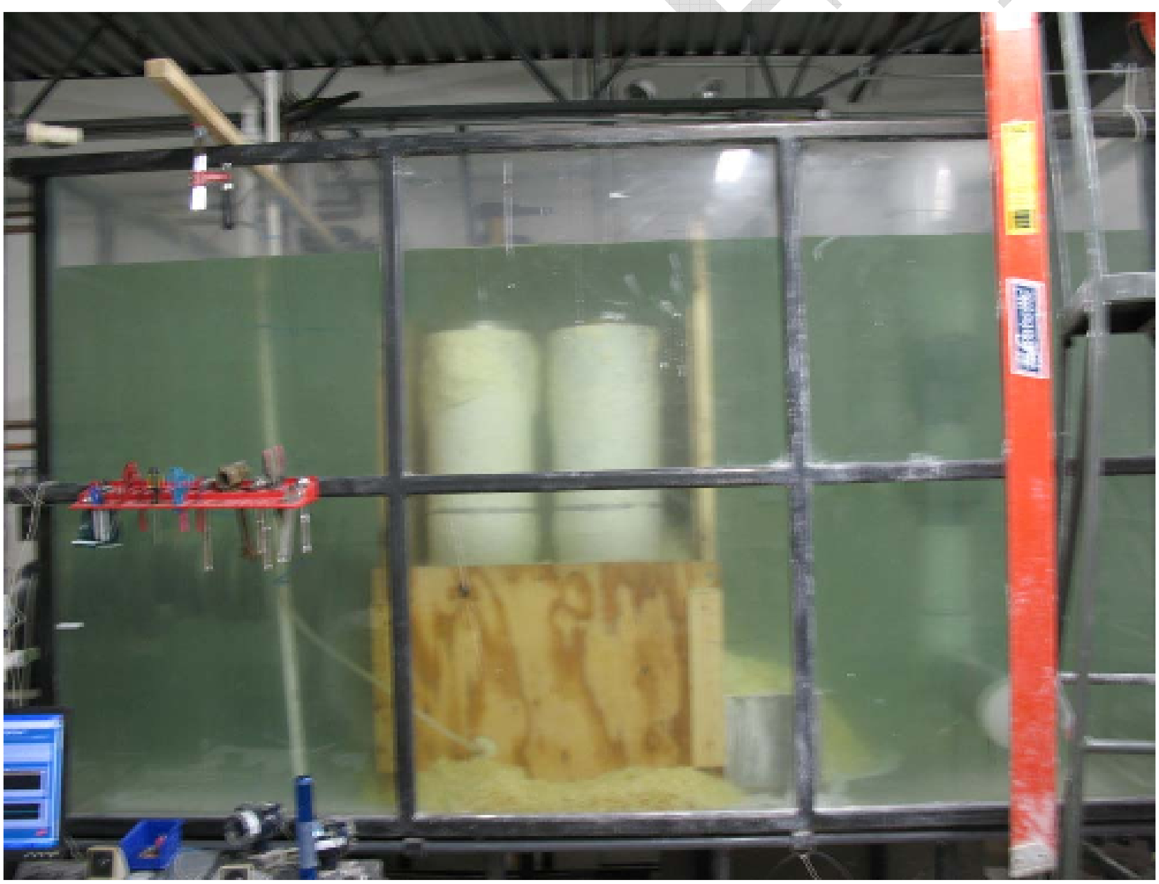
Alion incorporated improvements to the test tank that would enhance agitation of the water to provide better suspension of debris. The barrel diffuser used in the March 2007 testing was replaced with a "tee-sparger" piping system. This arrangement distributed the water at floor level as it was re-circulated from the strainer plenum back into the tank. This configuration also generates somewhat higher velocities from water entering the tank than were achieved with the barrel diffuser. The distribution piping was configured such that the debris accumulated on the strainer screen would not be disturbed by discharge from the sparger.

The full load test (Test 2B) was initiated in November 2007. As debris was slowly introduced to the tank over approximately 25 minutes, manual agitation was performed with a propeller style trolling motor and a rowing oar to supplement the sparger system. All agitation activities were carefully monitored to ensure they did not affect debris that had accumulated on the strainer. Review of the test logs reveals that supplemental agitation actions were performed throughout the entire debris addition process until head loss was observed to be stabilized.

At the conclusion of the test, it could be seen that Alion's improvements to tank agitation methods greatly reduced the amount of settled debris. Photograph 3 below illustrates the tank condition after all debris had been introduced to the experiment. This photograph shows the southwest corner of the tank and can be directly compared to Photograph 1 from the March 2007 test (1B).

Photograph 3 – Post Debris Addition TMI-1 Test 11/07 (southwest corner)

After all debris had been introduced to the tank and consistent attempts to keep the debris in suspension were performed, a small amount of fibrous debris could still be observed in isolated areas of the test tank floor. Photograph 4 shows the final condition of the test. By observation, the only debris component observed to have settled is the largest fiber class. The majority of the fibrous debris, along with the particulate and chemical precipitate debris had accumulated on the sump screen. The amount of settled fiber at the end of Test 2B is estimated to be approximately 10%. Since the bed thickness in this full load case is 1.1", a reduction of 10% would change the bed thickness to 1". A difference of 0.1" in bed thickness in the maximum load case is negligible. As shown, based on the clarity of the water, the particulate has been filtered and the head loss is in general higher with higher particulate to fiber ratios (thinner bed) assuming fiber loads that do not fill in the interstitial volume (which is the case here). The head loss at this point is dominated by the thin, tightly packed debris layer on the surface of the screen. The settled debris is extremely "fluffy" (roughly 98% voids), therefore the impact of this debris on the measured head loss would be insignificant. As can be seen in the photograph, there is already a considerable amount of the fluffy debris within the sump box. Based on this, the settled debris does not have a significant effect on the results.



Photograph 4 – TMI-1 Test 11/07

**Prototypical Features**

The TMI-1 sump pit design incorporates framing and structural components that form surfaces and confined volumes which are all within the volume of the pit, but are elevated above the base of the top hat mounting frame, or isolated from the primary sump volume. Figure 1 shows an isometric representation of the TMI-1 top hat framing structure that is installed within the sump pit. The entire assembly illustrated below is installed at the bottom of the sump pit, such that approximately 12" of the top of the tallest strainer cylinders extends above the containment floor elevation.

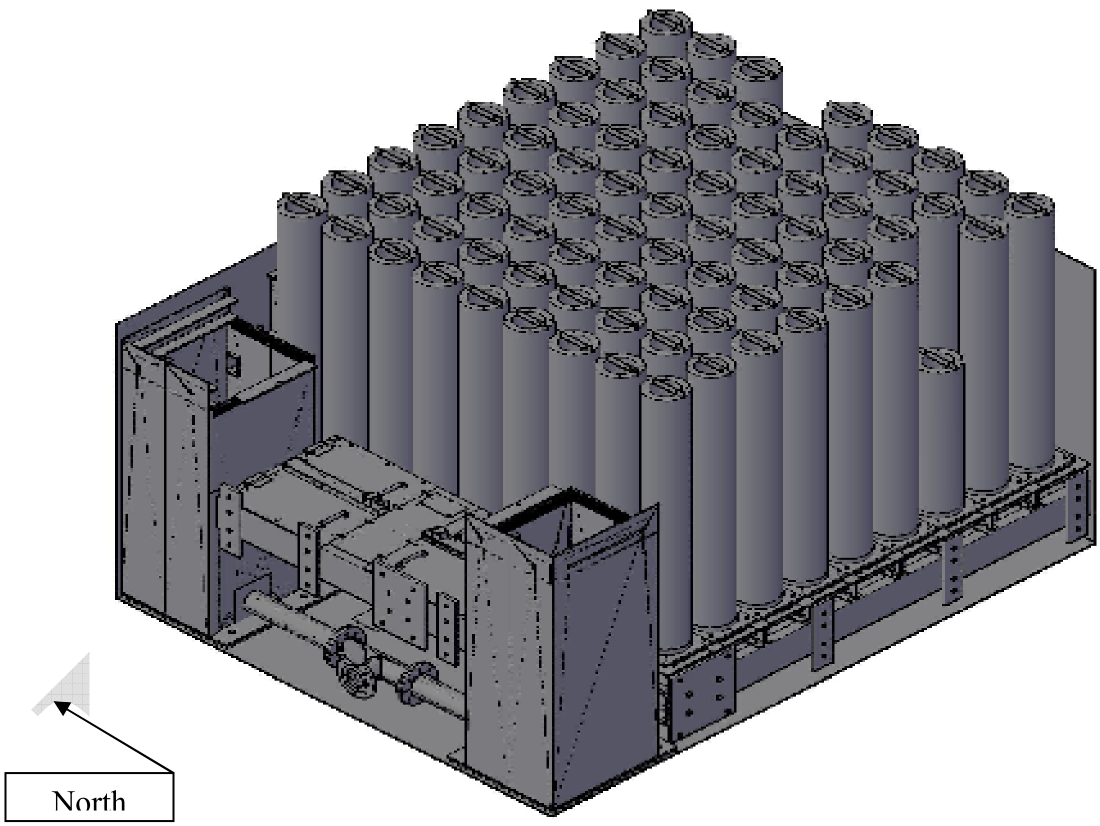



Figure 1 – TMI-1 Top Hat Framing Structure

For reference, Figure 2 below illustrates flow patterns and relative velocities generated within the flooded containment during ECCS operation. From this figure, it can be seen that the majority of the water entering the sump pit approaches from the west side of the structure.

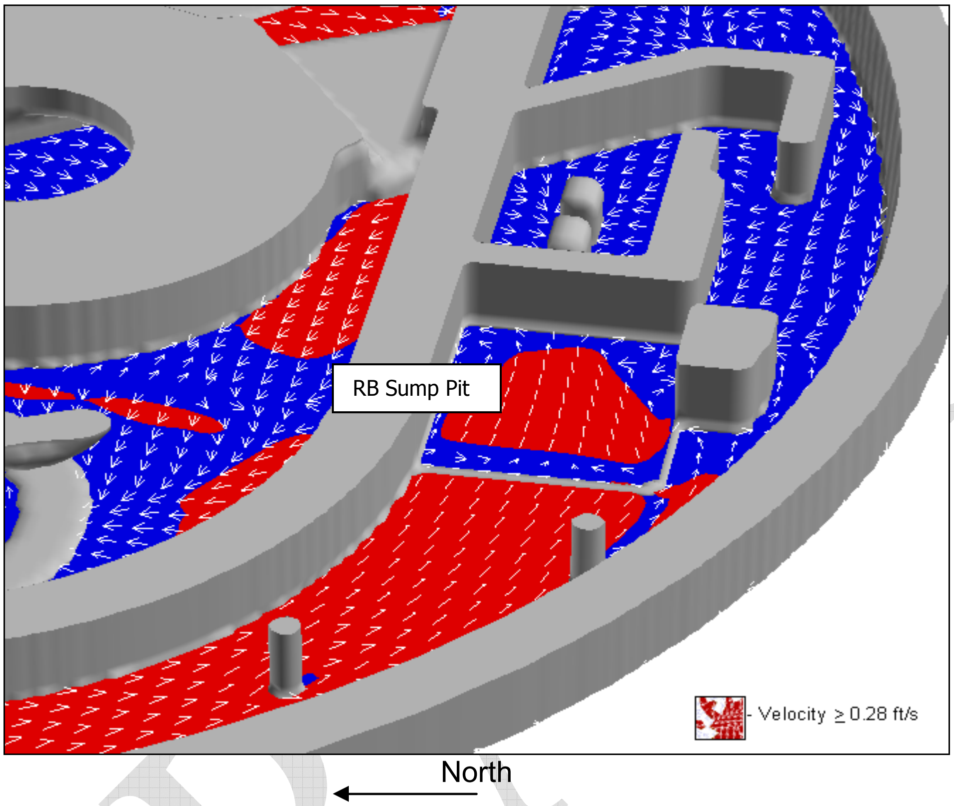



Figure 2 – Flow Profile During ECCS Operation, RB 281' Elevation

Examination of the physical layout reveals that the design contains inherent surface features that result in locations where debris could accumulate without coming into contact with the strainer screen. Specifically, the west side of the structure incorporates multiple flat plate hatches that provide access to the ECCS sump suction inlets (not shown) entering the pit. These hatches are closed during operation. On either side of these hatches are the normal sump drain tanks. These tanks have open tops and are cross tied with a discharge (shown) independent from the ECCS discharge. The volume within these tanks is isolated from the general sump volume. As sump water flows into the west edge of the sump pit, the entrained debris will initially interface with these surfaces and volumes of the framing structure.

Since these areas are separated from the base of the top hats, any debris that accumulates on these surfaces within the sump pit would not contribute to head loss. By examination of design drawings, the area of the framing structure above the top hat mounting framework is calculated to be 21 percent of the total pit cross section. This represents 38 ft2 of surface within the sump where debris with greater settling velocities could accumulate without contributing to head loss across the strainer.

As illustrated by the test, some types of standardized debris, which can analytically be expected to transport to the sump, could in fact settle on available surfaces in the immediate vicinity of the strainer array. The limited amount of settled debris in the November 2007 test is separated from the strainer in a manner similar to what could occur in the actual sump installation. Therefore, the minor settling noted in the full load test is prototypical and of a relatively small amount, such that the head loss results are not affected in any significant manner.

From a holistic standpoint, it should also be pointed out that the debris generated by the break assumes complete 100% destruction and removal of all debris within the spherical Zone of Influence into the small-fine debris mixture introduced into the prototype test. All test data has been developed based on limited target destruction data of a specific pipe and seam orientation. Given the geometry in the Pressurized Water Reactor, it is unrealistic and overly conservative to assume that 100% of the debris within the Zone of Influence is destroyed into 60/40 small-fine/large pieces dislodged and transported to sump pool. Pipe orientation, seam orientation, shielding, reflection and holdup all reduce the quantity of debris generated and available for transport. Based on the significant increase in screen size for TMI-1 and a realistic (reduced) debris generation scenario, the realistic debris quantity on the sump screen in the case of the large break loss-of-coolant accident might well be the thin-bed debris loading which has shown to considerably lower than the maximum debris load case. TMI-1 has tested five (5) separate load cases to explore the head loss that might be expected for such a thin bed and to assure that this thin-bed load case would not produce the limiting head loss. Additionally, recent testing using the new March 2008 test protocol for another utility with the same configuration as TMI-1 (approach velocity and sump design) produced a virtually identical thin-bed head loss with a slightly higher particulate load and Mineral Wool. The TMI-1 screen design does have Net Positive Suction Head (NPSH) margin under all conditions and based on the discussion above regarding debris loadings, the 10% settlement is certainly bounded by the conservatism in the methodologies employed.

**General Question (No Previous RAI Reference)**

Please evaluate the potential for deaeration of the sump fluid to occur as it flows through the debris bed. The guidance in Regulatory Guide 1.82, Revision 3, Appendix A, states that entrained gas at the pump inlet can result in an increase in required NPSH. Please evaluate whether any adverse effect to pump performance could occur as a result of entrained gas at the pump inlets. If applicable, provide an evaluation of the effects on the pumps.

**Response Summary:**

Attachment V-1 of the SE states, “It is generally accepted that a pump will experience cavitation problems when its inlet void fraction exceeds about 3%.” Additionally, Regulatory Guide 1.82, Revision 3, Appendix A states that degradation may occur at levels greater than 2%. An analysis is being performed to evaluate the potential for void formation at the pump inlet. Preliminary results indicate that the void fraction at the entrance to the pump suction line is less than 2%, therefore there is no adverse effect to pump performance.