WOLF CREEK
NUCLEAR OPERATING CORPORATION

Terry J. Garrett
Vice President Engineering

November 4, 2009

ET 09-0031

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

References:
1. Letter ET 08-0003, dated February 29, 2008, from T. J. Garrett, WCNOC, to USNRC
2. Letter ET 08-0053, dated December 22, 2008, from T. J. Garrett, WCNOC, to USNRC
3. Letter dated July 31, 2009, from USNRC to R. A. Muench, WCNOC (ADAMS Accession No. ML092030628)
4. Letter dated September 28, 2009, from USNRC to R. A. Muench, WCNOC (ADAMS Accession No. ML092460714)

Subject: Docket No. 50-482: Supplemental Information Regarding NRC Request for Additional Information for Responses to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors"

Gentlemen:

By letter dated July 31, 2009 (Reference 3), NRC transmitted a request for additional information (RAI) regarding the Wolf Creek Nuclear Operating Corporation (WCNOC) responses to Generic Letter (GL) 2004-02 (References 1 and 2, ADAMS Accession Nos. ML080700356 and ML090060877, respectively). WCNOC and Union Electric Company (AmerenUE) subsequently participated in a public phone call with the NRC on August 27, 2009 (Reference 4). During the August 27th phone call with the NRC, WCNOC and AmerenUE agreed to provide a video of the testing performed by ALDEN Research Laboratory, Inc. (Alden) showing separation of the fibrous debris in representative and conservative manner for NRC staff review.

Pursuant to 10 CFR 50.54(f), this letter provides video descriptions of the Alden testing in support of WCNOC's response to the NRC's GL 2004-02 RAIs (Reference 3). Enclosure I to this letter provides a description of the transport tests performed, and Enclosures II and III provide the digital video disks (DVDs) of two transport tests. As stated in Enclosure I, the vendor testing performed supports both Wolf Creek Generating Station and Callaway Plant.

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No regulatory commitments are made to the NRC by this letter. If you have any questions concerning this matter, please contact me at (620) 364-4084, or Mr. Richard D. Flannigan at (620) 364-4117.

Sincerely,

Terry J. Garrett

TJG/rlt

Enclosures: I Alden Video Description of the Fiber Debris Transport Testing
II Video of Flume Transport Test #1, Latent Fiber Transport Test
III Video of Flume Transport Test #2, Smalls Transport Test

cc: E. E. Collins (NRC), w/e
G. B. Miller (NRC), w/e
B. K. Singal (NRC), w/e
M. C. Thadani, (NRC), w/e
Senior Resident Inspector (NRC), wo/e

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Terry J. Garrett, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By ______________________
Terry J. Garrett
Vice President Engineering

SUBSCRIBED and sworn to before me this 4th day of November, 2009.

NOTARY PUBLIC OFFICIAL SEAL STATE OF KANSAS
RHONDA L. TIEMEYER
MY COMMISSION EXPIRES
January 11, 2010

Rhonda L. Tiemeyer
Notary Public

Expiration Date January 11, 2010

Enclosed is the report by ALDEN Research Laboratory, Inc. describing the fiber debris transport testing performed for Wolf Creek Generating Station and Callaway Plant.

November 2, 2009

Fiber debris transport testing for the Wolf Creek and Callaway power plants

For the testing there are two video cameras that are taping the flume. The right most screen is the upstream camera and is intended to show the debris introduction. The left camera shows the transport of material downstream of the introduction. Flow is therefore from right to left for both video screens.

The testing was conducted in the small flume for visualization purposes. The testing is intended to replicate flume velocities generated during full scale head loss testing completed previously for the Wolf Creek and Callaway power plants. The velocity plot used for full scale head loss testing is shown in Figure 1, and the wall geometry tested in full scale head-loss testing is shown in Figure 2.

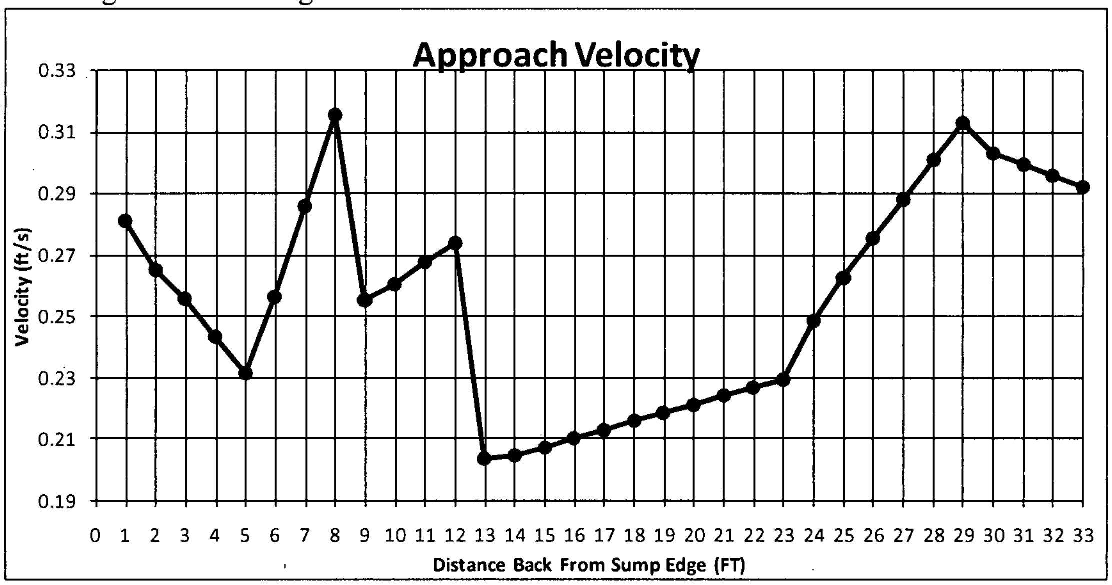

Figure 1. Approach velocity profile

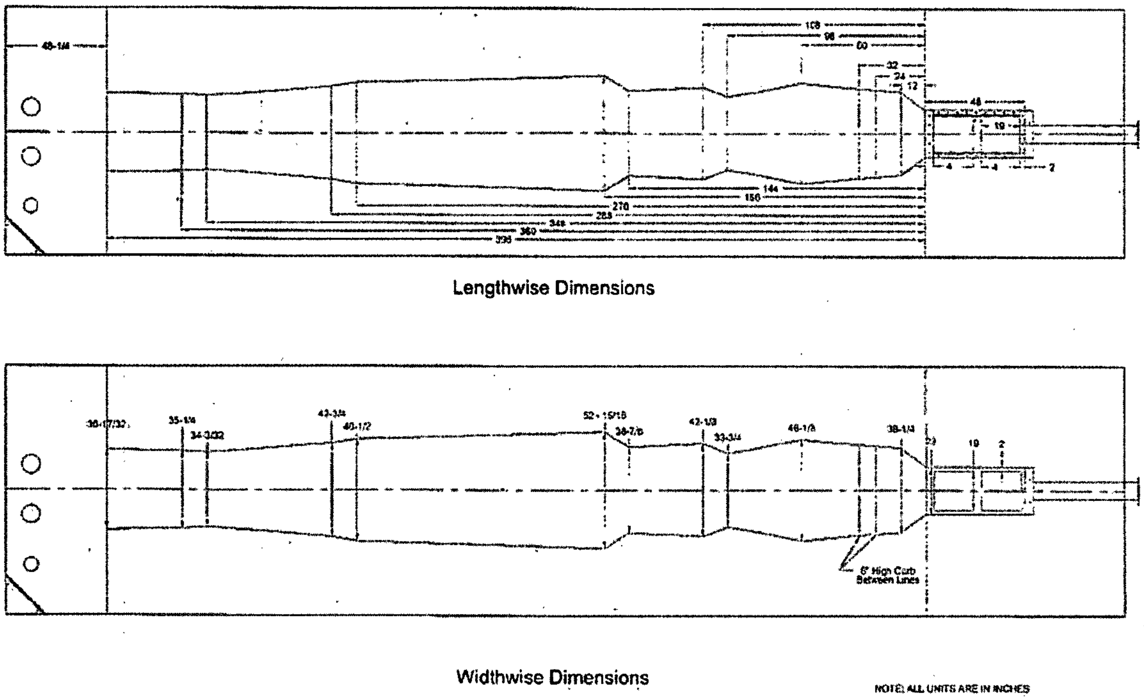

Figure 2. Large flume configuration

For the small flume tests documented herein, the approach velocity profile over the last 16 feet of flow stream is replicated, corresponding to the region of the profile containing the slowest velocities. Replicating the slowest velocities represents a conservative approach to showing that the latent fiber settled on the floor after introduction with the pump stopped can be readily transported to the strainers. Likewise, replicating the slowest velocities for debris introduction is conservative because the shear induced release of fines will be relatively lower at lower velocities. The flow rate to achieve the target velocities is approximately 439.4 gpm. The flume plan view is shown below in Figure 3. The flume water depth for the present testing is maintained at the large flume test level of 28".

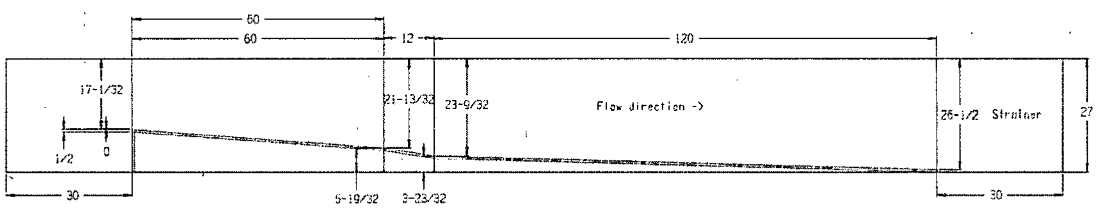

Figure 3. Small flume flow configuration

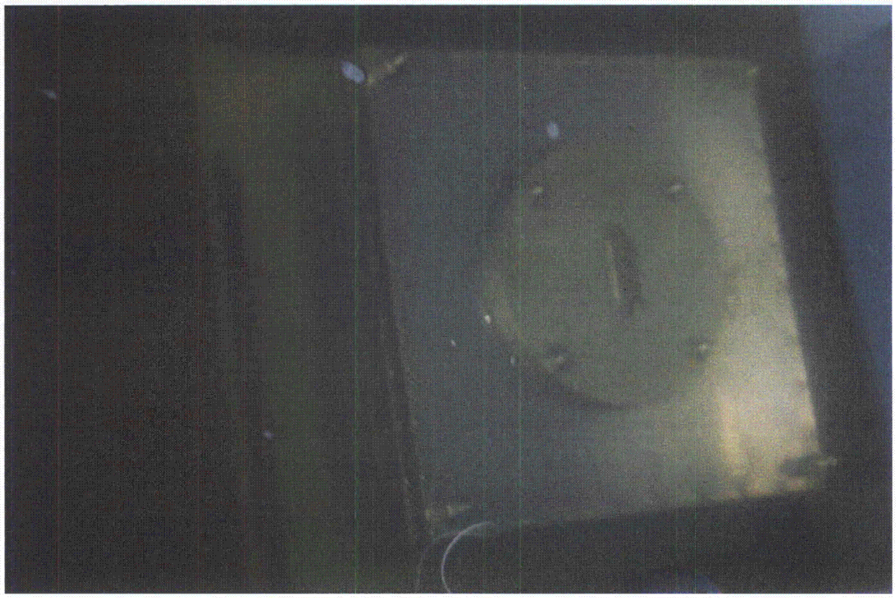

Figure 4. Clean strainer at start of test

Test 1 Nukon fines added to a quiescent flume water column

- 0:00 – 0:51 (14:32:59 – 14:33:50): The pump for the flume is off and the flume is quiescent. (Figure 4)
- 0:51 - 2:25 (14:33:50 – 14:35:24): The Nukon fines (0.25 lbm), prepared as during head loss testing with electric drill and mixing paddle, are being added across the length of the flume. The fiber breaks up upon entry into the flume. The fiber falls relatively uniformly, while some clouds of less dense fiber can be observed.

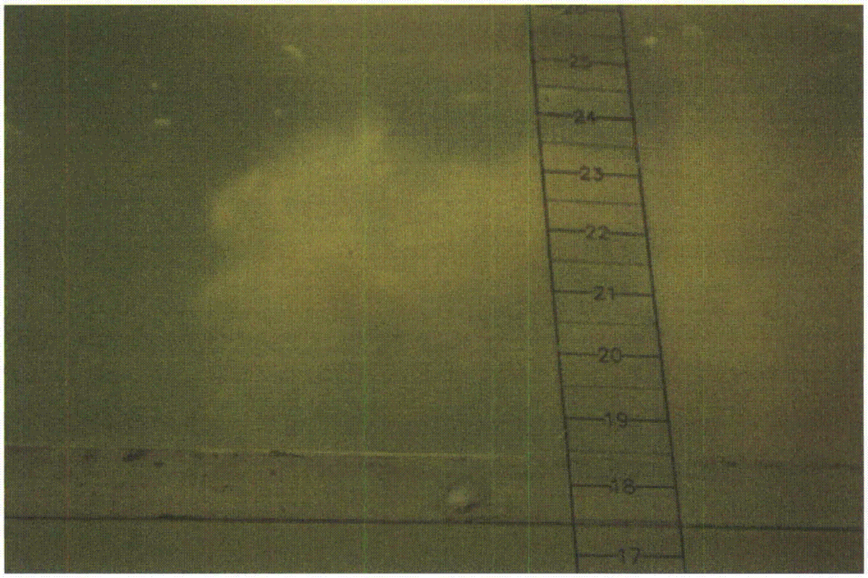

Figure 5. Latent fiber settling on flume floor

- 2:25 – 8:43 (14:35:24 – 14:41:42): The fiber has all been placed into the flume, and the five minute settling period has begun. All of the fiber will have settled onto the flume floor by the end of this five minute period.
- 8:43 – 10:05 (14:41:42- 14:42:04): The pump has just been started and the flow rate of 439.4 gpm or slightly higher has been established in the flume. The fiber can be observed moving downstream. A cloud of fiber is lifted off of the flume floor and transports downstream.

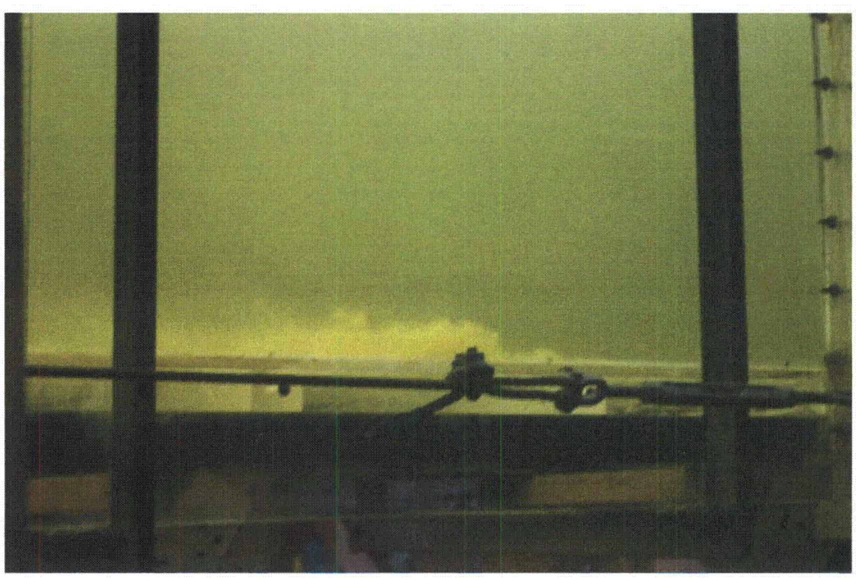

Figure 6. Latent fiber leading edge being pulled downstream

- 10:05 – 16:40 (14:42:04 – 14:49:39): More than half the fiber has moved downstream and little fiber remains to be transported. The movement of the fiber downstream is still occurring but at a reduced rate (Figure 6).
- 16:40 – 37:18 (14:49:39 – 15:10:17): More than ¾ of the fiber has transported to the strainer by this time. The last small tufts of fiber are being transported to the strainer.

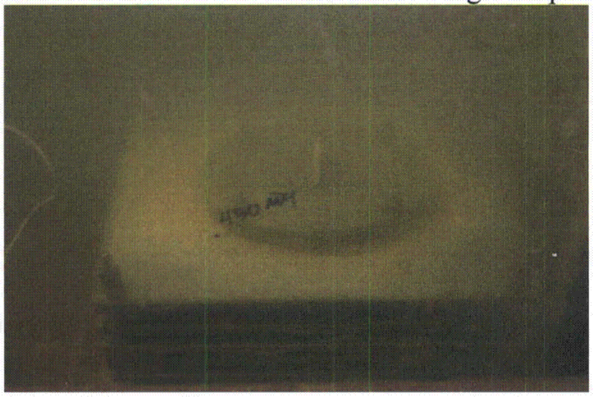

Figure 7. Latent fiber on screen at test termination

The quantity of Nukon fines introduced represents the smallest quantity that allows straightforward visualization of transport. Based on the surface area of the flume model, the directly scaled debris quantity would have been 0.125 lbm. It is conservative to determine fiber transport with a higher density of fiber settled on the floor as the likelihood of generating larger agglomerations that do not transport to the strainer is greater.

Figure 8 shows the head loss profile as a function of time at the strainer. Although absolute measured values do not have particular meaning, the profile of head-loss is still relevant. On this time scale (not synchronized to the video), the pump is started just beyond the 6 minute mark. The head loss rises quickly due to the transported fiber. The rate of increase slows considerably with time, as expected. The head-loss curve also confirms that a large portion of the introduced latent fiber, greater than 80%, was transported to the strainer within 15 minutes of pump start. Visual inspection of the flume at the end of testing confirmed that all latent fiber transported to the strainer area. This conclusion is further supported by the very flat head loss curve near the test termination.

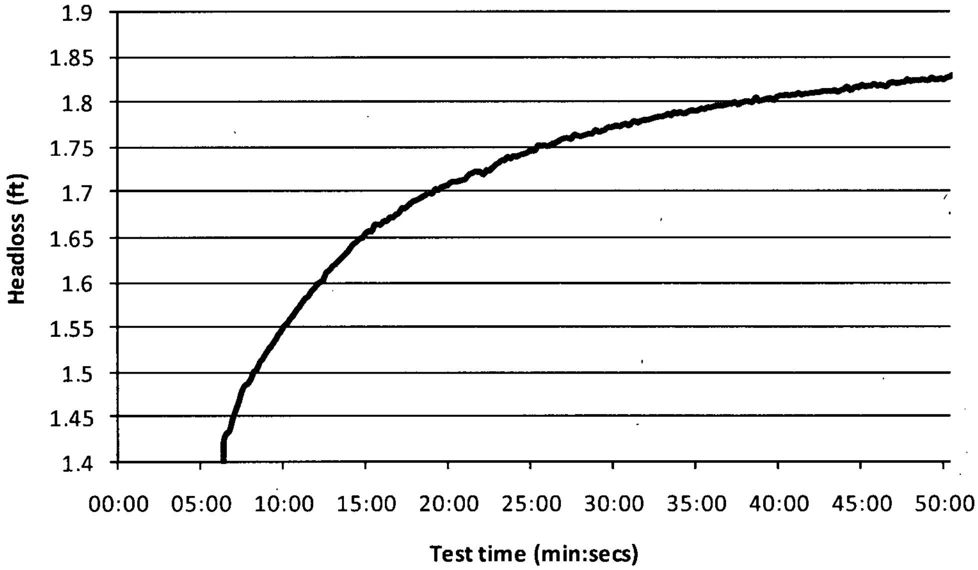

Figure 8. Head-loss profile for latent fiber addition

Test 2 Nukon Smalls added to the flume with an established flow

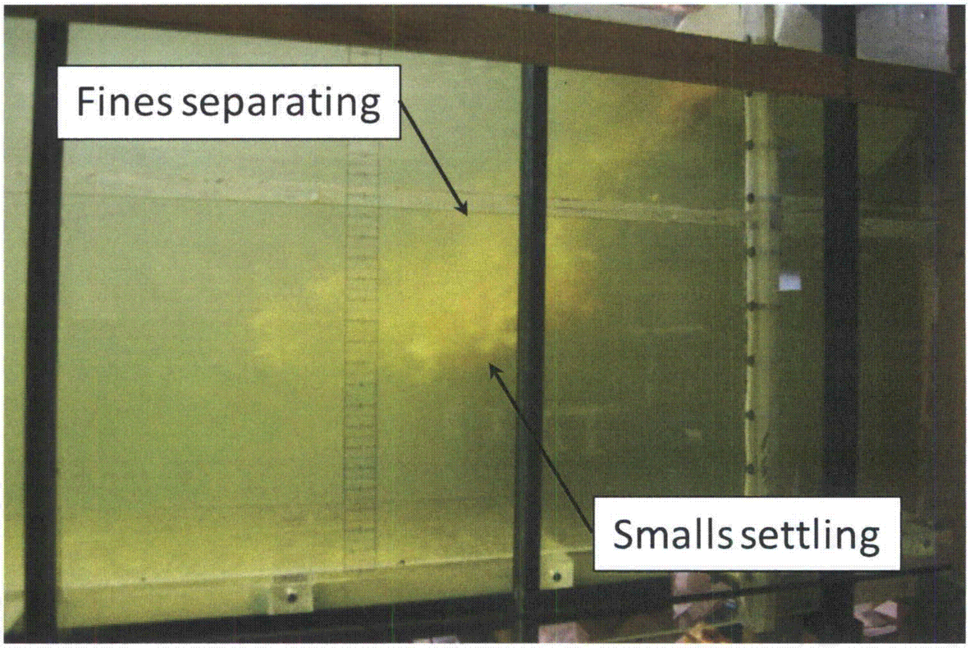

Figure 9. Smalls fiber addition

- 0:00 – 1:37 (15:34:54 – 15:36:31): The flow rate of approximately 439.4 gpm is established in the flume.
- 1:37 – 2:51 (15:36:31 – 15:37:45): The Nukon small fiber is added in the same manner as the fiber was added in the large flume testing. A total of 2.24 lbs of Nukon has been introduced into the flume at this time. A debris cloud of lighter fiber can be observed breaking away during the introduction (Figure 9).
- 2:51 – 5:00 (15:37:45 – 15:39:54): The lighter smaller fiber and individual fiber is transporting to the strainer at this time, while the heavier fiber material is starting to accumulate on the floor (Figure 10). It should be noted that small agglomerations of fiber or "clumps" can be seen entering the water column on introduction. These small clumps form very quickly in the introduction vessel. The water used to wet and prepare the debris is hot (approximately 120°F, similar to the conditions for head loss testing) to remove entrapped air. This also leads to rapid settling of the fiber to the bottom of the introduction vessel (fiber settles very quickly in hot water) once mixing has ceased. The clumps are thus not formed by inadequate mixing but by rapid settling of the fiber in the preparation bucket. As such, the clumps that are formed from fiber loosely settling in the introduction vessel can be seen to break up readily in the water column and release entrapped fines and disintegrate into even smaller clumps of fiber. The video shows what appear to be several additions of fiber. However, the additions represent the rinsing of the fiber from the bottom of the bucket which is also performed during head loss testing.

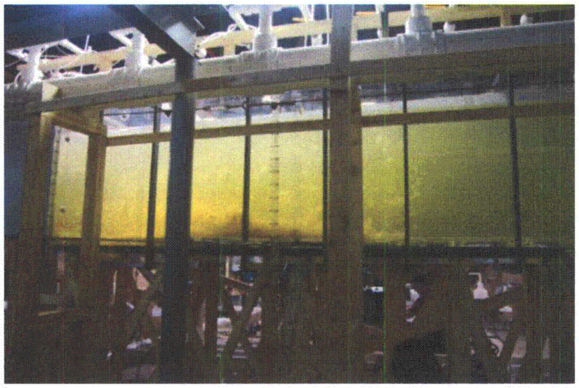

Figure 10. Fibers settling in flume downstream of introduction

- 5:00 – 6:02 (15:39:54 – 15:40:56): The flow rate is still being maintained. At this point in time a large pile, approximately 6" high and several feet long has established itself in the flume. This pile is located approximately 10 feet from the area of introduction. The velocity at this point is lower than the introduction zone causing the debris transport to slow. The velocity profile followed for the flume parallels the selected portion of the head loss flume approach velocity profile (see above). The settling observed here is prototypical of large flume head-loss tests at similar velocities.
- 6:02 – 6:58 (15:40:56 – 15:41:52): All of the fiber has been added to the flume.
- 6:58 – 9:51 (15:41:52 – 15:44:45): The fiber that has been introduced into the flume has all either settled or transported to the strainer. The fiber that is moving in the video is all being transported across the bed of fiber on the flume floor. The fiber pile is releasing small tufts from the leading edge of the debris pile.
- 9:51 – 50:00 (15:44:45 – 16:24:54): The release of tufts from the leading edge of the fiber pile continuously slows. Some additional small fiber pieces continue to break away, but the pile size and shape remains largely unaffected.
- 50:00 – 55:00 (16:24:54 – 16:29:59): Documentation of the location of the fiber has taken place at this time.

The introduced quantity of smalls is calculated based on a volume flow rate ratio between the head loss test and the presently conducted transport test. The scaling on flow rate is appropriate for drop-zone introduced debris. The total amount of smalls introduced for the transport test is further divided by the number of batches employed to introduce the debris into the head loss test (5). The transport test thus reproduces appropriately the debris concentration employed during head loss testing.

Figure 11 shows a picture of the strainer near the end of testing. It is clear from this picture that a significant amount of fines were released from the smalls and traveled to the strainer. Given that Figure 7 shows the picture of 0.25 lb of latent fine fiber on the screen, it is possible to conservatively conclude that at least twice this amount separated from the introduced small fiber and made it to the strainer in the smalls introduction test.

Figure 11. Fine fiber on strainer after smalls introduction

Figure 12 shows the head-loss profile as a function of time for this test. Note the relatively quick steep initial increase. This is evidence of fines directly transported through the water column to the strainer. The slower rate of increase later in the test is indicative of floor transport of debris and is much more gradual. However, the most significant jump in head loss occurs in the early part of testing and supports the significant fines release estimate made above. The transport time for the flow to move from the introduction zone to the strainer is approximately 2 min 30 secs, based on an average velocity of 0.21 ft/sec over the modeled length of the head loss flume. Based on this and the fact that debris introduction starts at approximately 1 min 37 secs into the test, debris suspended in the water column would begin causing an increase in head loss at approximately 4 minutes as observed in Figure 12. Furthermore, note that debris introduction ends at 6 min 58 secs into the test. Fiber transported suspended through the water column from the last amount of introduced fiber therefore is expected to reach the strainer at 9 min 30 secs. The head loss curve shown in Figure 12 shows a clear change in the slope at this point. It can therefore be concluded that a significant amount of fiber separated upon introduction and traveled to the strainer suspended in the water column, a behavior consistent with fiber fines. Note that the video shows further release of fine fiber tufts that transport to the strainer and cause the slower rate of head loss increase observed over the remaining period.

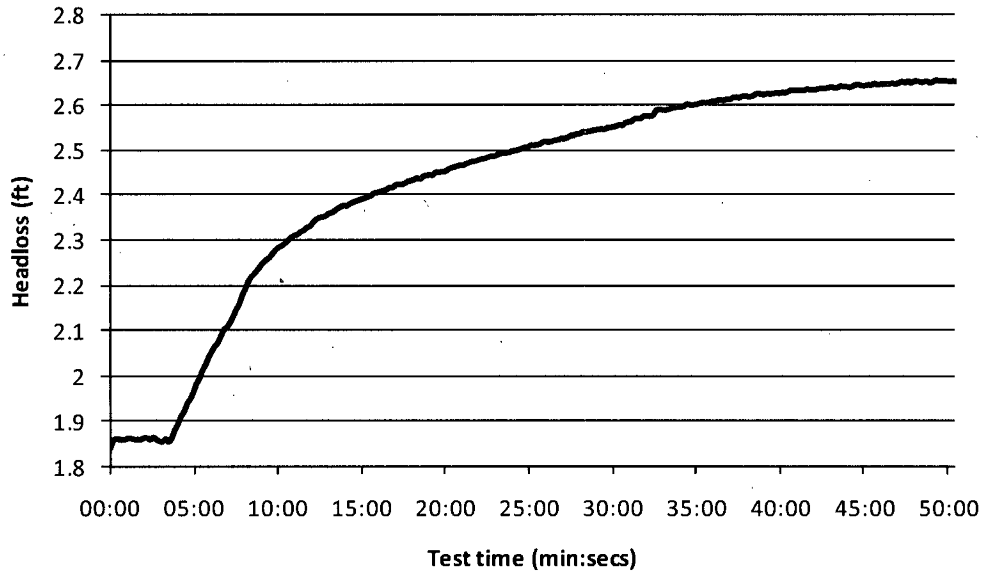

Figure 12. Head loss profile in time for smalls addition

Enclosed is the digital video disk (DVD) submittal of the ALDEN Research Laboratory, Inc. test described in Enclosure I. The DVD is labeled: Flume Transport Test #1, Latent Fiber Transport Test.

Enclosed is the digital video disk (DVD) submittal of the ALDEN Research Laboratory, Inc. test described in Enclosure I. The DVD is labeled: Video of Flume Transport Test #2, Smalls Transport Test.