September 2, 2010

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

FROM: Blake A. Purnell, Project Manager ***/RA/***
Generic Communications and Power Uprate Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF AUGUST 4, 2010, TELECONFERENCE WITH PERFORMANCE CONTRACTING, INC. AND LICENSEES TO DISCUSS ITS LARGE FLUME TEST PROTOCOL

On August 4, 2010, U.S. Nuclear Regulatory Commission (NRC) staff held a teleconference with representatives of Performance Contracting, Incorporated (PCI) and its partners (the vendor) to discuss technical issues concerning PCI's large flume test protocol for testing pressurized-water reactor containment sump strainer performance. Client licensees of PCI also participated in the call. This teleconference was closed to the public due to the proprietary nature of the discussions. This teleconference was a continuation of a teleconference held on July 28, 2010. A publicly available summary of the July 28 teleconference is available in the NRC Agencywide Documents Access and Management System (ADAMS) under Accession Number ML102160080.

The following proprietary PCI documents were discussed at this meeting:

- PDT-2010.07.26-1 Rev 0, "Approach Velocity Analysis," prepared by Alden Research Laboratory, Inc., dated July 2010
- PDT-2010.07.26-2 Rev 0, "Narrow Flume Influence Evaluation Procedures," prepared by Alden Research Laboratory, Inc., dated July 2010
- PDT-2010.07.26-3 Rev 0, "Flume Turbulence Control," prepared by Alden Research Laboratory, Inc., dated July 2010

DISCUSSION OF "APPROACH VELOCITY ANALYSIS"

The NRC staff stated that the approach for calculating the flume turbulence should include conservatism that is sufficient to account for uncertainties. In lieu of existing diagnosis and treatment for bimodal flow distributions, the NRC staff recommended using the two-thirds value from the distribution across the entire flume for both velocity and turbulence.

If a single break scenario is modeled in testing, the NRC staff stated that flume flows should be determined based on the limiting break with regard to debris transport in the near-field region modeled during strainer testing.

The vendor agreed to consider the basis for the number of pathlines chosen for analysis of velocity and turbulence from a statistical convergence standpoint.

The vendor and NRC staff agreed that strainers without flow control could be addressed by weighting pathlines based on mass flow. NRC staff noted after the phone call that care should be taken in this case to ensure adequate statistical convergence for the calculated velocity and turbulence.

The vendor and NRC staff agreed that flow averaging would be an appropriate basis to combine flows associated with geometrically separate non-independent strainer modules with flow control.

For cases where less than 50 percent of the pathlines originate more than one flume length away, the vendor and NRC staff agreed that a shorter flume should be used for testing with a length that is based on including at least 50 percent of the pathline origins. NRC staff also agreed with an alternate proposal to appropriately split the recirculation flow, provided acceptable debris addition distances were used. In either case, NRC staff noted that care should be taken to ensure adequate statistical convergence for the calculated velocity and turbulence despite the decreased number of pathlines.

DISCUSSION OF SCALING OF TURBULENCE BY TEMPERATURE

During the July 28, 2010, meeting (Action A7 of the meeting summary), the vendor stated it was unable to find a reference that the NRC staff had previously cited [*Mechanics of Sediment Transport*, by Chien and Wan].

During this meeting, the NRC staff stated it had re-examined the reference and determined it does not provide unique data relevant to the scaling of turbulence by temperature. NRC staff stated that a review of this reference is not necessary for the vendor to address this item (Action A7), and a paper previously referenced by the vendor authored by Gibbs, et al., contains similar and more comprehensive settling data for spherical particles of various sizes. NRC staff's comparison of the two references showed similar observed behavior for particles of similar size.

NRC staff noted several key points that would need to be addressed by the vendor if turbulence scaling were to be pursued:

1. Application of data from spherical particle settlement to fibers, including collections of tangled fibers or small clusters as opposed to 100 percent individual fibers.
2. Selection of a scaling factor that applies to a range of potential particle sizes.
3. Selection of an appropriate post-accident temperature for scaling. For example, use of a maximum temperature would be non-conservative. Use of the temperature at switchover would also be non-conservative, since debris transport occurs over time.

The vendor stated that turbulence scaling with temperature was not being pursued at the present time but could be reexamined in the future depending on the outcomes of other efforts.

DISCUSSION OF "FLUME TURBULENCE CONTROL"

The vendor's approach to implement adequate turbulence in test flume remains a work in progress pending resolution of prerequisite issues affecting turbulence. NRC staff stated that currently accepted drainage models are conservative, but alternative approaches have not been successful to date in quantifying and removing unnecessary conservatism. NRC staff has seen evidence that, irrespective of drainage flow, inherent characteristics of the flume design relative to plant flow channels (e.g., reduced width, increased straightness) tend to reduce turbulence in the test flume as compared to the plant condition for flows of equivalent velocity.

DISCUSSION OF "NARROW FLUME INFLUENCE EVALUATION PROCEDURE"

NRC staff stated that its concern with narrowness of the test flume applies to all debris types. Potentially different means exist to address the issue for fine, suspendable debris and for debris that may tumble along the flume floor. For example, controlling debris addition rate in the large flume test protocol could avoid agglomeration of fine debris suspended in the test flume.

NRC staff stated that the flume width sensitivity testing proposed by the vendor may provide insights into debris transport behavior in a flume, but it would be of limited value because it would not bound debris transport conditions that could occur either in plant containment pools or in Alden's large test flume with regard to several important scaling parameters:

1. The quantity of debris per unit flow channel width
2. The quantity of debris per unit floor area
3. The quantity of debris per unit fluid volume

NRC staff considered narrowness of the test flume to be one of the most significant concerns associated with the large flume test protocol, particularly given the length of the flume. The vendor made several points during the call concerning conservatisms in the debris preparation and sequencing protocols that NRC staff agreed to consider further with respect to whether they mitigate or partially mitigate the issue. The points made by the vendor were as follows:

- All fiber fines are introduced prior to smalls.
- The new introduction method of fibers prevents the fibers from agglomerating.
- Five flume turnovers will separate the introduction of fiber fines from small fibers.
- The PCI "smalls" are fiber clumps that pass through a 1 x 4 grating opening. The industry classification for smalls includes fiber clumps that pass through a 4 x 4 grating opening. Therefore, the debris form PCI uses is very conservative.
- No large fiber classes will be tested. Smalls will be used in lieu of any larges specified.
- If smalls come to rest in the test flume at a flow rate of 60% (or 67%) of the median, there is no expectation for this fiber to transport to the screen or to climb the screen if it does tumble to the screen. There is no expectation that tumbling "smalls" will contribute to the head loss across the screen; and as such, this issue should not be a major concern.

- The sensitivity testing will be used to provide guidelines on how to control the batch sizes introduced into flumes so as to diminish if not eliminate any concern with narrow flume walls affecting debris transport and therefore, the head loss measured.

NRC staff will provide feedback on these points made by the vendor in a future teleconference.

ACTION ITEMS STATUS

The following is an update to the action items listed in the July 28, 2010, meeting summary.

Action A2: Vendor will provide methodology for calculating flume velocity by July 26, 2010.

> **Status:** By letter dated August 12, 2010, the vendor provided the document titled "Approach Velocity Analysis." This document was discussed during this meeting. Action A2 is closed.

Actions A3 and A4: The vendor will provide a plan and system description for its new method to introduce turbulence by pulsing nozzles. The vendor stated that it would provide contour plots of an example plant and a line plot of simulated turbulent kinetic energy versus that in test flume, both based on CFD. NRC staff will provide feedback.

> **Status:** By letter dated August 12, 2010, the vendor provided the document titled "Flume Turbulence Control." This document was discussed during this meeting and was considered to be a work in progress. No due date for Actions A3 and A4 was discussed.

Action A5: Vendor will provide test plan on flume wall effects by July 26, 2010.

> **Status:** By letter dated August 12, 2010, the vendor provided the document titled "Narrow Flume Influence Evaluation Procedures." This document was discussed during this meeting. Action A5 is closed.

Action A7: Vendor will provide a path forward on scaling turbulence based on temperature by August 30, 2010. This action is to address the NRC staff's concern that the vendor's cited references do not support a particular increase in turbulent kinetic energy to determine settlement of fine fiber.

> **Status:** Action A7 was discussed during this meeting and remains open.

Action B5: NRC staff will be able to provide detailed feedback to PCI on the "Approach Velocity Analysis" document on August 4, 2010. NRC staff will try to provide feedback on the flume wall effects test plan at the same time (see Action A5).

> **Status**: NRC staff provided feedback on both of these items during this meeting. Action B5 is closed.

Action B6: NRC staff will relook at the reference referred to in Action A7 and consider whether it is needed.

Status: NRC staff provided feedback during the discussion of turbulence by temperature. Action B6 is closed.

NEW ACTION ITEMS

Action C1: The vendor will provide an update to the "Approach Velocity Analysis" document by September 9, 2010.

Enclosure: List of Attendees

cc: James Bleigh/PCI

Action B6: NRC staff will relook at the reference referred to in Action A7 and consider whether it is needed.

> **Status**: NRC staff provided feedback during the discussion of turbulence by temperature. Action B6 is closed.

NEW ACTION ITEMS

Action C1: The vendor will provide an update to the "Approach Velocity Analysis" document by September 9, 2010.

Enclosure: List of Attendees

cc: James Bleigh/PCI

DISTRIBUTION: See last page

ADAMS ACCESSION NUMBER: ML102180217

OFFICE	LA:DPR:PGCB	PM:DPR:PGCB	BC:DSS:SSIB	PM:DPR:PGCB
NAME	CHawes (GLappert for)	BPurnell	MScott	BPurnell
DATE	9/1/10	9/1/10	9/2/10	9/2/10

List of Participants for August 4, 2010,
Meeting With PCI and Licensees

Name	Affiliation
Stu Cain	Alden Research Laboratory
Chuck Feist	TXU Generating Company LP (Comanche Peak)
Jim Bleigh	PCI
Chris Kudla	PCI
Ludwig Haber	Alden Research Laboratory
George Goralski	Entergy Nuclear Operations, Inc. (Palisades)
Bill Beckius	Entergy Nuclear Operations, Inc. (Palisades)
Wes Schulz	STP Nuclear Operating Co.
Scott Putman	Kewaunee
Ron Holloway	Wolf Creek Nuclear Operating Corp.
Tom Kendall	FPL Energy Point Beach, LLC (Point Beach)
Steve Smith	NRC
John Lehning	NRC
Blake Purnell	NRC

Enclosure

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RidsOgcMailCenter

Blake Purnell
Stacey Rosenberg
Paul Klein
John Lehning
Michael Scott
Stephen Smith
Sher Bahadur
Robert Taylor
James Vail