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From: Clinton Shaffer [CShaffer@arescorporation.com]
Sent: Friday, September 10, 2010 8:12 PM
To: NRCREP Resource
Subject: Solicited Public Comment to Draft Regulatory Guide DG-1234 Dated July 2010 Entitled: "Water Sources for Long Term Recirculation Cooling Following a LOCA"

I wish to comment on DG-1234, specifically regarding the prototypical head loss testing section. I have extensive qualifications in this area. As a contractor, I was a member of the NRC GSI-191 audit team and I have reviewed, observed, and conducted head loss testing for the NRC.

An inconsistency exists in the prototype head loss testing section, Section 1.2.12. ITEM 1.2.12.b properly states that "The conditions within the test tank should be prototypical or conservative with respect to the plant sump or suppression pool including the postulated limiting debris loading, the recirculation system hydraulics, and key aspect of various accident scenarios." ITEM 1.2.12.c properly states that test specification should be designed to determine the worst case head loss from all the possible types of debris that could accumulate given the bounding quantities of debris. ITEM 1.3.11.b correctly states that testing and analyses have indicated that the maximum head losses can occur when a sufficiently thick layer of fibers results in a thin dense low-porosity layer of debris (generally referred to as a thin bed). The problem and inconsistency is a statement in Item 1.3.12.f, which states "Agitation of the test fluid with stirrers may be necessary to achieve complete transport." This statement conflicts for three reasons. First, artificial agitation likely disrupts the prototypicality of the test tank defined in ITEM 1.2.12.b. Second, if the agitation is in proximity of the strainer, the agitation can affect debris accumulation in a non-prototypical manner. Third, agitation can cause larger debris to accumulate that would not realistically accumulate in the prototypical sump pool.

The realities associated with the new large replacement PWR strainers have changed greatly from the realities of the preceding generation of strainers but unfortunately much of the preceding mindset still exists in head loss testing. The new reality is that the prototypical sump pool surrounding these large strainers is often nearly a still pool of water. Typical prototypicality is strainer perimeter average flow approach velocities less than 0.1 ft/s and the velocity through the accumulated bed of debris less than 0.01 ft/s. The clear implication is that any debris prone to settling within a pool of water will have settled and under typical conditions would remain settled. Therefore, what remains to be accumulated on strainer is the very fine particulate and fiber debris that tends to remain in suspension for hours or days even in still water. The prototypical accumulation of such debris would result in a thin bed of tightly packed relatively low porosity debris capable of causing relatively high head losses. Note that the debris bed capable of the higher head loss is also the prototypical debris bed. Therefore, it is essential that qualification head loss testing recreate the prototypical thin-bed debris bed. The old mindset was that head loss always increased with debris quantity but the new reality is that the non-porous thin-bed causes the greater head loss. Artificial agitation too close to the test strainer or the introduction of debris too close to the strainer defeats the formation of a prototypical debris bed.

The seriousness of potential thin-bed head losses is illustrated by a test observed by NRC staff at Alden Research Laboratory on February 12-13, 2008 as described in the trip report by Steve Smith dated April 30, 2008. This test had to be prematurely terminated when the test head loss exceeded 28 ft.

An example of using agitation to force the accumulation of debris that would not accumulate under prototypical conditions is found in the Waterford audit report. The Waterford licensee installed a large GE replacement strainer and conducted qualification testing using both a very small-scale sector test and a reduced-scale modular test. The sector test apparatus was used to perform the thin-bed testing. The sector testing induced artificial agitation to keep shredded debris in suspension until complete accumulation was accomplished. These shreds would not have remained in suspension under prototypical plant conditions. The audit report noted non-uniform bed formations that were most evident by sudden drops in the head loss that occurred during fully stirred sector testing. The staff inferred from Waterford Unit 3 test data showing sudden large head loss drops that the accumulation of shreds within the sector gap may have caused an entrance dam to form

and then give way. Such behavior would not happen under prototypical conditions and no thin-bed result was reported during the audit.

The staff observed another GE test that was conducted for Fort Calhoun on August 29, 2005 [trip report dated 8/29/05, pilot audit report, App. II]. This test was a modular test where the post-test debris bed was described as having a uniform and glossy appearance that was suggestive of a layer of particulate and the trip report stated that the debris accumulation appeared to be a classic thin-bed debris accumulation. Bottom line is that a thin-bed accumulation is a likely result for the GE strainer installed at Waterford but the audit presentation failed to show a thin-bed test result and the reason was that the thin bed testing used agitation to force shreds to accumulate in a non-prototypical manner. The Waterford testing, as audited, was in general compliance with DG-1234. Hence, the guidance in DG-1234 is not only inconsistent but also inadequate. While a holistic review approach was used in the GSI-191 reviews of current vendor testing, the holistic approach should not be built into Regulatory Guide 1.82.

In addition, the following sentence in Item 1.3.12.f needs fixing or clarification: "Scaling of the debris areal density on the test tank floor should be considered relative to the plant condition." With all my experience, I do not understand this sentence.

As an additional follow on comment, I would like to point out that more use should be made of hindsight. At the beginning of testing, we did not know how to write valid test guidance. Each vendor took their own path leading to diverse approaches, some of which are reflected in the overall complexity of DG-1234. In my opinion, it is now possible to prescribe a singular worst case qualification head loss test for use by all vendors that is prototypical of most of the large PWR replacement strainers. That singular test would be the classic thin-bed test properly conducted. Analysis determines the bounding quantities of fine fibers and particulates where fine is defined as a material so fine that the material would remain suspended for hours if not days in still water. The test creation of such materials should be done hydraulically using a prototypical transport flume such that all other materials settle to the floor. Note that the sources of the fine fibers include a portion of the LOCA generated debris, continued erosion of the larger fibrous debris, and the latent fibers and are more or less physically represented by individual fibers or very small groupings of fibers. The trick is to introduce sufficient quantities at the upstream end of the prototypical flume so that the masses actually transported to the test strainer as fines equal the analytical bounding assessment for fines. Separate testing could determine the transport fraction arriving at the strainer typical of the vendor method of debris preparation that would be used to determine the introduced quantities (i.e., the assessment quantity divided by the transport fraction equals the introduced quantity). The procedure would be to start the pump, introduce all particulate debris (except late mission chemical effects), and then very slowly feed in the fibers allowing head loss to catch up between small introduced batches. One test could just about cover the head loss testing issue, with the possible exception of late mission chemical effects. Based on experience, the licensee likely would not pass this test if large quantities of particulate insulation debris (e.g., calcium silicate) or chemical effects precipitant is introduced. Thus licensees would then be required to remove from containment nearly all such problematic particulate insulation materials and to prevent the formation of early chemical effects. This would leave the accumulation of hardened particulate typically consisting coating debris and dirt. Analysis indicates that hardened particulate likely is not capable of causing the high head losses seen with the more problematic materials. Late in the mission chemical effects may well be handled by risk and/or time-related mitigation strategy arguments. While this comment was aimed at strainer head loss, a similar comment may help address the downstream head loss, as well.

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