UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 4, 2010

Mr. David A. Heacock
President and Chief Nuclear Officer
Dominion Nuclear Connecticut, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: MILLSTONE POWER STATION, UNIT NOS. 2 AND 3 – REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER 2004-02 (TAC NOS MC4694 AND MC4695)

Dear Mr. Heacock:

By letter dated March 13, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML090750436), Dominion Nuclear Connecticut, Inc. (DNC or the licensee) submitted a response to a request for additional information (RAI) regarding the response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," for Millstone Power Station, Unit Nos. 2 and 3 (MPS2 and MPS3, respectively).

The Nuclear Regulatory Commission (NRC) staff has reviewed the RAI responses and concluded that additional information is needed to assess whether there is reasonable assurance that Generic Letter 2004-02 has been satisfactorily addressed at MPS2 and MPS3. The information needed is found in the enclosed RAI. The draft questions were sent to Mr. William Bartron, of your staff, to ensure that the questions were understandable, the regulatory basis for the questions was clear, and to determine if the information was previously docketed.

Further, the NRC staff plans to conduct a public meeting (teleconference) with DNC to discuss its proposed path forward and to address each RAI question. If necessary, based on the outcome of the first meeting, additional public meeting(s) will be scheduled to resolve any remaining issues.

A response date for the enclosed RAIs will be established at the public meeting (teleconference).

If you have any questions regarding this matter, please contact me at 301-415-1603.

Sincerely,

Carleen J. Sanders, Project Manager
Plant Licensing Branch 1-2
Division of Operating Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosure: As stated

cc w/encl: Distribution via Listserv

REQUEST FOR ADDITIONAL INFORMATION

RESPONSE TO GENERIC LETTER 2004-02

MILLSTONE POWER STATION, UNIT NO. 2

DOCKET NO. 50-336

On September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," as part of the NRC's efforts to assess the possibility that the emergency core cooling system and containment spray system pumps at domestic pressurized-water reactors (PWRs) would experience a debris-induced loss of net positive suction head (NPSH) margin during sump recirculation. By letters dated March 3, 2006, March 28, 2006, and November 21, 2007,[1] guidance on GL supplemental responses was provided by the NRC staff. By letters dated March 4, and September 1, 2005, November 15, and December 19, 2007, and February 29, and December 18, 2008,[2] Dominion Nuclear Connecticut, Inc (DNC or the licensee) provided a response to the GL for Millstone Power Station, Unit No. 2 (MPS2). By letter dated December 17, 2008,[3] the NRC requested additional information regarding the MPS2 GL 2004-02 response. By letter dated March 13, 2009,[4] DNC provided a response to the request for additional information (RAI). The NRC staff is reviewing and evaluating the March 13, 2009, response and has determined that responses to the following questions are necessary in order to complete the review.

The NRC staff, consistent with the discussion in the "Reasons for Information Request" section of GL 2004-02, is using sample audits to help verify that addressees have resolved the concerns identified in the GL. The NRC staff conducted a detailed audit of the new sump strainer design and associated analyses and testing for MPS2. The audit was conducted the week of January 22, 2007. The results of the audit were provided to DNC in a letter dated August 30, 2007.[5] Included in the August 30, 2007, letter is a list of open items.

The attached questions are formatted so they correspond to the previous RAI responses dated December 17, 2008. The Chemical Effects questions are new and do not correspond directly to the previous RAI. The previous RAI concluded with question number 11; the new questions are numbered 12-15.

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[1] Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML060620050, ML060870274, and ML073110269, respectively

[2] ADAMS Accession Nos. ML050630559, ML052500378, ML073190553, ML090860438, ML080650561, and ML083650005, respectively

[3] ADAMS Accession No. ML083230469

[4] ADAMS Accession No. ML090750436

[5] ADAMS Accession No. ML072290550

RAI 3[6] DNC's response is unclear as to how likely it is that the stream of break flow will be broken-up. Based on the MPS2 audit, the NRC staff believes that a significant portion of one of the strainer arrays is located in a loop compartment beneath piping subject to breaking. Without a cover plate, it is difficult to conclude that liquid falling from the break would not fall into the containment pool above the strainer array with sufficient kinetic energy to result in air entrainment. Also, the NRC staff notes that page 7 of Attachment 1, to the December 18, 2008, DNC letter states that ". . . many of the possible break locations are above a portion of the strainer and break flow in these areas would keep the portion of the strainer below the break clear of debris." It is not clear to the NRC staff why air entrainment would not occur if many of the breaks result in water falling from the break onto the strainer such that the affected portion of the strainer is continually cleared off. Also, the flow-controlling baffles inside the strainer may encourage uniform flow, but when energetic water is splashing down onto a strainer array from above, it is not clear how the baffle can limit the air entrainment to a negligible quantity. It is not clear that the strainer baffles were designed to compensate for such a non-uniform external flow. Please clarify these points.

The basis for the claim that air will escape from the strainer fins is not clear. Based on the description in the responses for MPS2, it is not clear why the 1-1/2 inch opening in the top of the strainer would perform differently than the rest of the strainer, or would not be covered with debris, just like any other strainer surface. Please clarify these points.

Regarding the Froude number discussion, the basis for the determination that air could not reach the suction pipes based on the Froude value was not clear. One particular point that was unclear concerned the assumed size of the air bubbles and whether the Froude number limit referred to was associated with vortexing or bubble ingestion. Please provide the basis or reference used for this assumption. MPS2 cites the head loss tests performed by Atomic Energy of Canada, Ltd (AECL). Some of the AECL head loss tests experienced air in the pump suction line. Please address how this impacts MPS2's evaluation of sump performance. Please address whether the Froude number was excessive for these tests (e.g., greater than 0.31). If there is direct testing evidence that could help resolve the question, please provide such documentation.

Based on the NRC staff's understanding, any air ingested by the strainer would seemingly remain trapped inside, accumulating until it was able to exit through the perforated plate or into the suction lines. Air ingestion is complex and it is unclear to the NRC staff which way the air would eventually go and how much would accumulate in the strainer before steady-state conditions are reached. The installation of a cover plate would prevent water from splashing down onto and entraining air into the strainer, removing some of complex issues associated with air ingestion.

Please address the above air ingestion concerns because excessive air ingestion can degrade operation of the pumps, which takes suction from the sump.

[6] Audit Open Item 3

Head Loss and Vortexing

RAI 6 This RAI identified some differences in non-chemical head losses between the two test facilities. The December 18, 2008, DNC letter provided the first docketed information providing significant information on the MPS2 Rig-89 testing. The NRC staff has reviewed this and determined that the following information is needed to complete the review:

a. Please provide information that justifies that the Rig-89 head loss test was conducted with a fibrous debris load that maximized non-chemical debris head loss.

b. Please provide information regarding whether the debris bed contained adequate fiber to ensure that a maximum head loss was attained without bed disturbances limiting the head loss.

Chemical Effects

Following review of the chemical effects evaluation details in the DNC December 18, 2008, letter, the NRC staff identified that the following additional information was needed in order to determine if the testing was performed in an acceptable manner:

12. The MPS2 calcium dissolution test at a pH of 7.0 resulted in a 30-day calcium concentration of 126 mg/L. DNC's December 18, 2008, letter states that the pH 7.0 case (without tri-sodium phosphate present) was used to determine the concentration of calcium in the Rig-89 test. However, the calcium concentration used for Rig-89 testing was 40.4 mg/L. Please justify why 40.4 mg/L is a representative value in the Rig-89 testing when the dissolution testing conducted with scaled quantities of concrete resulted in a calcium concentration of 126 mg/L.

13. In Attachment 1, Table O-2, of DNC's December 18, 2008, letter, the calcium concentration for time infinity is shown as 117 mg/L for pH 7.0. Please explain why this concentration for time infinity is appropriate, given the 30-day bench test calcium concentration at pH 7.0 was 126 mg/L.

14. DNC's testing was performed at 104 °F, which is well below early post-loss-of-coolant accident pool temperatures. The solubility of calcium phosphate (hydroxyapatite) decreases as the temperature increases. Please discuss whether more calcium phosphate precipitate would have formed in the Rig-89 tests if this test would have been performed at higher temperature. If more calcium phosphate precipitate would be expected at a higher temperature, when the short-term NPSH margin is applicable, please justify why the overall Rig-89 test results provide for an adequate evaluation of chemical effects.

15. Please compare the total amount of aluminum that is predicted to be released by the AECL model with that predicted by the WCAP-16530 base model (i.e., no refinements for silicate or phosphate inhibition). Discuss any significant differences between the plant-specific predictions for the two methods, including the acceptability of these differences.

REQUEST FOR ADDITIONAL INFORMATION

RESPONSE TO GENERIC LETTER 2004-02

MILLSTONE POWER STATION, UNIT NO. 3

DOCKET NO. 50-423

On September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," as part of the NRC's efforts to assess the possibility that the emergency core cooling system and containment spray system pumps at domestic pressurized-water reactors (PWRs) would experience a debris-induced loss of net positive suction head (NPSH) margin during sump recirculation. By letters dated March 3, 2006, March 28, 2006, and November 21, 2007,[1] guidance on GL responses was provided by the NRC staff. By letters dated March 4, and September 1, 2005, November 15, and December 19, 2007, and February 29, and December 18, 2008,[2] Dominion Nuclear Connecticut, Inc (DNC or the licensee) provided a response to the GL for Millstone Power Station, Unit No. 3 (MPS3). By letter dated December 17, 2008,[3] the NRC requested additional information regarding the MPS3 GL 2004-02 response. By letter dated March 13, 2009,[4] DNC provided a response to the request for additional information (RAI). The NRC staff is reviewing and evaluating the March 13, 2009, response and has determined that responses to the following questions are necessary in order for to complete the review.

The attached questions are formatted so that they correspond to the responses from the previous RAI, dated December 17, 2008. The Chemical Effects questions are new, and do not correspond directly to the previous RAI. The previous RAI concluded with question number 13; the new questions are numbered 14-17.

Head Loss and Vortexing

RAI 6 Please provide the following additional information to document that the MPS3 strainer evaluation provides adequate assurance that it will perform as required under accident conditions:

1. The December 18, 2008, DNC letter provides contradictory information on the amount of fibrous debris added during the test. On page 8, Attachment 2, it is stated that the limiting bed was determined to be 1/4 inch during earlier testing.

[1] Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML060620050, ML060870274, and ML073110269, respectively

[2] ADAMS Accession Nos. ML050630559, ML052500378, ML073190553, ML0908604380, ML080650561, and ML083650005, respectively

[3] ADAMS Accession No. ML083230469

[4] ADAMS Accession No. ML090750436

Yet the same paragraph states that only two increments, containing fibrous debris to form 1/16 inch bed each, were added to the test and that no further fiber was added. Page 16 states that two 1/16 inch additions were made and implies that two further additions were made later. In addition, the graph on page 19 shows 4 fibrous additions. Describe, in detail, the initial fibrous debris conditions of the test and the amount of any additions that were made during the test.

2. The December 18, 2008, DNC letter states that the limiting thin bed for MPS3 is 1/4 inch as determined by previous testing. However, the head loss plot on page 19, Attachment 2, indicates that the third and fourth 1/16 inch fiber additions had little effect on head loss. Please evaluate the thin bed thickness for MPS3 in consideration of these points. Also, if the thin bed for the Rig-89 test is different from that of other tests that were used to provide Rig-89 test inputs, please provide an evaluation of how the final qualification test could have been affected by the use of such inputs. The licensee's assertion that 55% of the debris attached to the strainer for the Rig-89 test, and 72% and 84% attached to the strainer for the reduced scale test should also be considered in this evaluation.

3. The difference in head loss between the two test methods is about an order of magnitude. The differences in non-chemical head losses between the two types of tests were attributed to contaminants from the use of river water and to air evolution caused by non-prototypically low submergence during the reduced scale tests. It was stated that particulate and biological activity in the river water affected the head loss in the reduced scale testing. Please provide additional details on how the river water particulate and biological activity affected the head loss. Please address the following items:

   a. Provide an evaluation of the degree to which the particulate and biological growth from the river water affected the results of MPS3. It appears that the MPS3 tests were affected to a much greater degree than other AECL tests conducted under similar conditions. Please discuss the reason MPS3 was affected to a greater degree.

   b. State whether any fiber-only tests were conducted using river water. If such tests were conducted, provide the head losses and other pertinent conditions for those tests.

   c. Provide an evaluation of the strainer head loss resulting from the particulate that was contained in the river water. Compare the expected test result, when the particulate from the river water and the test debris particulate are present, with the result when only the test debris is considered. Provide the assumptions and the bases for the assumptions used in this evaluation.

   d. Provide an evaluation of whether the reduced scale testing, which was used as an input for the Rig-89 qualification testing, provided valid input due to the non-prototypical biological growth and particulate from the river water.

4. Please provide additional details on how the postulated air evolution affected the MPS3 head loss tests considering the following:

   a. Please provide an evaluation of how the air evolution phenomenon affected the MPS3 tests compared to other AECL tests conducted under similar conditions. Please provide information on why air evolution, as a factor in head losses, would only occur for AECL strainers.

   b. The response to RAI 4 stated that the air evolution began to affect head loss as soon as the fibrous debris was added to the test and that the head loss began to decrease as soon as fibrous debris additions were stopped. Please provide an evaluation of why the air evolution would begin to affect head loss as fiber was added to the test and why it would stop as soon as fibrous debris additions were stopped.

   c. Please provide an evaluation of why the evolution of air, caused by the addition of fibrous debris with air entrained in it, would result in the highest head loss when a relatively small amount of fibrous debris was added.

5. Figure O-4 on page 22, Attachment 2, of the December 18, 2008, letter showed that following chemical debris additions head loss would increase, then decrease back to the pre-addition value. Please evaluate this behavior considering that it may have been caused by bed degradation. Consider whether higher head losses may have occurred had additional fibrous debris been present to provide structural support to the debris bed.

6. Please provide an evaluation of the potential for the lower head loss in the Rig-89 testing (versus reduced scale testing) to have been caused by agglomeration of debris, especially fibrous debris.

7. Please provide information that justifies that air evolution will not affect pump NPSH margins or strainer head loss in the plant. Provide the key assumptions used in the evaluation and the bases for these assumptions.

Net Positive Suction Head

RAI 9 It is not clear how water drains from the refueling cavity into the reactor cavity, and whether this drainage path is large enough to ensure that debris blockage would not occur. While the plant Final Safety Analysis Report (FSAR) documents that a significant amount of venting surface is available, there is also a significant quantity of debris available. The potential for blockage of the vent covers is also considered in the FSAR.

The RAI intended to ask about the entire refueling cavity; did your response account for the entire refueling cavity or only the cavity saddle? If your RAI response did not account for the entire refueling cavity, please update your response.

To ensure that the evaluation has accounted for the worst-case minimum containment water level, please clarify the drainage path from the refueling cavity to the reactor

cavity, the minimum flow restrictions, and provide a basis for why blockage would not occur there.

Chemical Effects

AECL performed dissolution tests both with and without tri-sodium phosphate (TSP) in the beakers. The testing showed that the tests that included TSP showed an inhibition of the calcium dissolution. However, for the head loss testing the licensee stated that they applied the calcium quantity determined by the uninhibited (non-TSP) bench testing. Data from the lowest allowable pH (7.0) was used when determining the amount of calcium to be added to the head loss test. The calcium concentration used for head loss testing was 14.7 mg/L. This value is significantly lower than the measured value for the 30-day bench scale dissolution testing, which used scaled amounts of concrete to represent the MPS3 condition. Please provide the following additional information in order to determine that the testing was performed in an acceptable manner:

14. The solubility data for calcium shows increased dissolution at lower pH ranges. In table O-2, Attachment 2, to the December 18, 2008, letter the calcium concentrations for pH 5.0 and 6.0 are lower than the concentration for pH 7.0. In addition, page 11 of 30 states that the concrete samples in the beaker tests fully dissolved in the pH 5.0 and 6.0 tests but were not fully dissolved in the pH 7.0 and 8.0 tests. Please explain why the bench tests at lower pH ranges, in which the concrete fully dissolved, resulted in lower concentrations of dissolved calcium than the bench tests at higher pH ranges, in which the concrete did not fully dissolve.

15. For MPS3, the calcium dissolution test at pH of 7.0 resulted in a 30-day calcium concentration of 78 mg/L. The December 18, 2008, letter states that the pH 7.0 case (without TSP present) was used to determine the concentration of calcium in the Rig-89 test. However, the calcium concentration used for Rig-89 testing was 14.7 mg/L. Please justify why 14.7 mg/L is a representative value in the Rig-89 testing when the dissolution testing conducted with scaled quantities of concrete resulted in a calcium concentration of 78 mg/L.

16. DNC's testing was performed at 104 °F, which is well below early post-loss-of-coolant accident pool temperatures. The solubility of calcium phosphate (hydroxyapatite) decreases as the temperature increases. Please discuss whether more calcium phosphate precipitate would have formed in the Rig-89 tests if this test would have been performed at higher temperature. If more calcium phosphate precipitate would be expected at a higher temperature, when the short-term NPSH margin is applicable, please justify why the overall Rig-89 test results provide for an adequate evaluation of chemical effects.

17. Please compare the total amount of aluminum that is predicted to be released by the AECL model with that predicted by the WCAP-16530 base model (i.e., no refinements for silicate or phosphate inhibition). Discuss any significant differences between the plant-specific predictions for the two methods, including the acceptability of these differences.

If you have any questions regarding this matter, please contact me at 301-415-1603.

Sincerely,

/ra/

Carleen J. Sanders, Project Manager
Plant Licensing Branch 1-2
Division of Operating Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosures: As stated

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