



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

April 29, 2016

Mr. Shane M. Marik  
Site Vice President and Chief Nuclear Officer  
Omaha Public Power District  
Fort Calhoun Station  
9610 Power Lane, Mail Stop FC-2-4  
Blair, NE 68008

SUBJECT: FORT CALHOUN STATION, UNIT NO. 1 – REQUEST FOR ADDITIONAL  
INFORMATION RELATED TO GENERIC LETTER 2004-02, "POTENTIAL  
IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION  
DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER  
REACTORS (CAC NO. MC4686)

Dear Mr. Marik:

On September 13, 2004, the U.S. 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." The GL addressed the potential susceptibility of pressurized-water reactor recirculation sump screens to debris blockage during design-basis accidents requiring recirculation operation of emergency core cooling systems (ECCS) or containment spray systems (CSS) and on the potential for additional adverse effects due to debris blockage of flowpaths necessary for ECCS and CSS recirculation and containment drainage.

By letters dated February 29 and October 16, 2008, Omaha Public Power District (the licensee) submitted supplemental responses to GL 2004-02 for Fort Calhoun Station, Unit 1. By letter dated February 12, 2010, the NRC staff requested additional information. By letter dated January 4, 2016, the licensee submitted responses to that request.

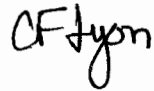
The NRC staff has reviewed the information provided in your response and determined that additional information is required in order to complete its formal review. The enclosed questions were provided to E. Matzke of your staff on April 15, 2016, and discussed with E. Matzke, et al., of your staff in a telecon on April 29, 2016. Please provide a response to the enclosed

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questions by September 16, 2016. If you have any questions, please contact me at 301-415-2296 or via e-mail at [Fred.Lyon@nrc.gov](mailto:Fred.Lyon@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "CF Lyon". The signature is written in a cursive, somewhat stylized font.

Carl F. Lyon, Project Manager  
Plant Licensing Branch IV-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosure:  
Request for Additional Information

cc w/encl: Distribution via Listserv

REQUEST FOR ADDITIONAL INFORMATION  
GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS  
BLOCKAGE ON EMERGENCY RECIRCULATION DURING  
DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"  
OMAHA PUBLIC POWER DISTRICT  
FORT CALHOUN STATION, UNIT NO. 1  
DOCKET NO. 50-285

On September 13, 2004, the U.S. 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" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML042360586). The GL addressed the potential susceptibility of pressurized-water reactor recirculation sump screens to debris blockage during design-basis accidents requiring recirculation operation of emergency core cooling systems (ECCS) or containment spray systems (CSS) and on the potential for additional adverse effects due to debris blockage of flowpaths necessary for ECCS and CSS recirculation and containment drainage.

By letters dated February 29 and October 16, 2008 (ADAMS Accession Nos. ML080650369 and ML082960244, respectively), Omaha Public Power District (OPPD, the licensee) submitted supplemental responses to GL 2004-02 for Fort Calhoun Station, Unit 1 (FCS). By letter dated February 12, 2010 (ADAMS Accession No. ML100150072), the NRC staff requested additional information. By letter dated January 4, 2016 (ADAMS Accession No. ML16006A048), the licensee submitted responses to that request. The NRC staff has reviewed the information provided in the response to the NRC staff request for additional information (RAI), and determined that additional information is needed, as described below.

**RAIs – Response Requested**

**RAI 10** – The NRC staff requested further justification for the use of Stokes' Law and turbulent kinetic energy (TKE) metrics to determine the settling of fine debris. OPPD did not directly address the staff's concerns, but instead demonstrated reasonable assurance, via computational fluid dynamics (CFD), that the steam generator (SG) compartment that does not contain the loss-of-coolant accident (LOCA) break will be stagnant to the point where debris will not transport out of the compartment. Even if a small amount of debris in the unbroken SG compartment transported due to the oscillatory velocities at the entrance to the compartment, it would not have a significant effect on the amount of debris that might transport to the strainers. Since the debris is effectively sequestered in the SG compartment, it can likely be assumed not to transport if it has been determined that transport of material out of the compartment does not occur prior to recirculation (e.g., during washdown). Based on the CFD analysis, the NRC staff concluded that there was likely reasonable assurance that a significant amount of debris would

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not transport out of the SG compartment with the unbroken loop during recirculation. The licensee should verify that a significant amount of debris will not transport out of the SG compartment with the unbroken loop prior to recirculation.

**RAI 11** – The NRC requested additional justification for the assumption that 10 percent of small and large piece fibrous debris in the pool will erode to fines. The NRC is aware that a proprietary industry report has been prepared that justifies the use of 10 percent erosion of small and large pieces of specific types of fibrous debris if a plant validates that the report is applicable to their plant conditions. The report that the NRC has reviewed is Alion Science and Technology's "Erosion Testing of Small Pieces of Low Density Fiberglass Debris – Test Report," Revision 0, dated March 31, 2010 (proprietary), and the NRC's staff's review dated June 30, 2010, is at ADAMS Accession No. ML101540221. If OPPD intends to credit this report, please verify that it is applicable to the FCS conditions and it is the report referenced here. If a different justification is used for the erosion rate, please provide it.

**RAI 12** – Please provide a response.

**RAI 15** – The NRC requested additional information to justify scaling of the head loss test results to post-LOCA temperatures based on viscosity. The staff was concerned that there may have been pressure-driven discontinuities in the debris bed that may make such a scaling scheme non-conservative. For the large-break LOCA (LBLOCA), the licensee stated that temperature scaling is not credited. Therefore, for the LBLOCA, this issue is not a concern. OPPD stated that for the small-break LOCA (SBLOCA), temperature scaling is credited. The licensee stated that bore holes are present in the debris bed which requires scaling to address the viscous and kinetic flow regimes when performing the scaling to a higher temperature. The staff agrees with the portion of the RAI response that states that bore holes are present at pressures lower than the maximum pressure tested, at a relatively low temperature. Please provide the basis for equation 3 of the OPPD submittal dated February 29, 2008. Explain why the viscosity and density terms are multiplied. Generally, the kinetic (turbulent, density) and viscous (laminar, viscosity) terms are combined by adding. Since the licensee demonstrated that the bore holes were present and had a similar effect on head loss between about 25 and 75 inches of water dP, it is acceptable to scale within this range of differential pressure.

**RAI 20** – The NRC staff requested additional information regarding how the velocities and turbulence in the test flume for the FCS strainer head loss test compared to similar metrics in the plant. RAI 20 contains additional details on the request so it will not be repeated here. No response was provided based on the premise that the licensee is awaiting the NRC acceptance of a test protocol discussed in RAI 10. However RAI 10 is on the transport analysis that determines how much debris reaches the strainer from the SG compartment with the unbroken loop. The NRC staff found the response to RAI 10 would likely be acceptable (with one open question), but could not determine how this relates to RAI 20. The NRC could not find any test protocol discussed in RAI 10. RAI 20 does not have any relationship to RAI 10 as it only covers the conditions that were present in the test and questions whether the conditions bounded those that would be present in the strainer near field in the plant. RAI 20 is not intended to question the conditions distant from the strainer, which is the subject of RAI 10. Please provide a response to RAI 20.

**RAI 25** – The NRC staff requested additional information on the justification for treating unqualified alkyd original equipment manufacturer coatings as chips. RAI 25 contains additional information regarding the staff concerns. The NRC staff has reviewed the January 4, 2016, response to RAI 25. The staff does not agree with the assertion that unqualified coatings will not fail if they are not subjected to spray or jet impingement. The NRC staff still needs additional information as detailed below.

- a. Please provide justification for treating unqualified alkyd coatings as chips.
- b. Since the original debris generation calculation, two telescoping cranes coated in unqualified alkyd coatings have been added. Please explain how OPPD plans to account for these coatings.
- c. Please provide the assumed size distribution for failed unqualified coatings in upper containment.
- d. Please explain how OPPD is crediting excess chemical precipitate included in the head loss testing to account for a shortage of particulate from coatings.

**RAI 35** – The NRC staff requested additional information regarding the licensee's credit for aluminum inhibition. The staff could not determine whether precipitation occurred at a delayed time or if precipitation was assumed not to occur. The licensee stated that a significant amount of aluminum had been removed from the containment resulting in a substantial reduction in the potential formation of aluminum precipitates. The licensee provided a table that compared the tested amounts of precipitate with the updated amounts predicted considering the removal of aluminum and no credit for silicate inhibition (see RAI 34). The licensee addressed the LBLOCA and the SBLOCA separately. For the LBLOCA, no solubility credit is taken. For the SBLOCA, the licensee stated that they would re-evaluate solubility at a pH value that can be justified. In addition, the licensee stated that they planned to remove fiberglass insulation within the zone of influence (ZOI) and anticipates that this will result in an open screen area on the strainer so that precipitates cannot result in additional head loss across the strainer. If the licensee can demonstrate that a filtering bed will not form, the NRC has concluded that this RAI response is likely acceptable. Please update the response.

**RAI 36** – Please provide a response. This RAI is related to RAI 20.

**RAI 38** – RAI 38 requests that the licensee describe how debris that may have settled in the test flume, but was predicted by the transport evaluation to reach the strainer, was treated. The NRC expects that any debris that is predicted to reach the strainer, but settles in the test flume, be accounted for in some manner. If it can be shown that the debris would actually settle in the plant by virtue of showing that the test conditions bound the plant conditions in the near field of the strainer, then allowing the debris to settle is acceptable. However, if the debris is shown to settle, and it is not fine debris, the erosion of this debris must be accounted for by adding fine debris to the test to account for erosion. Alternately, the licensee may demonstrate that the fiber that settled in the test would be eroded in the test similarly to how erosion in the plant is assumed to occur. If the amount of debris that settled in the test flume is considered to be insignificant, please provide the amounts of each type of debris that settled and a basis for considering any potential erosion from the source insignificant. Please provide a response to RAI 38.

**RAIs 39-47** – OPPD describes reliance on the ZOI for Nukon secured by Sure-Hold bands and describes how the FCS insulation system is at least as robust as one installed with Sure-Hold bands. The ZOI being applied to the Nukon is 3D. The discussion is regarding a 3-inch pressurizer spray line. The response references testing of Nukon tested with Sure-Hold bands and testing of Cal-Sil with aluminum jacketing and stainless steel bands. It is unclear why the Cal-Sil testing is applicable to a Nukon insulation system. The final sentence of the write-up indicates that banding must be installed on the Nukon to allow the 3D ZOI to be applied. In the response to RAI 3, the licensee stated that fiberglass insulation on the 3-inch pressurizer spray line is being replaced with reflective metallic insulation (RMI). Please explain if this is the same spray line discussed in the response to RAIs 39-47. Please provide details on the insulation being evaluated as detailed below:

- a. what type insulation is being evaluated
- b. location of piping on which the insulation is installed
- c. testing or guidance applied to justify the ZOI for the insulation
- d. comparison of the tested insulation system with the installed system including:
  - i. line size
  - ii. banding type, material, and dimensions
  - iii. jacket type, material, and dimensions
  - iv. status of the installation of additional banding, if applicable.

**New Question 1** – Since the debris source term has potentially changed significantly, once the licensee has finalized the plant configuration, please provide a comprehensive list of debris by size and type for each break considered limiting for FCS. Provide a comparison of the debris source term amounts for each break to the debris test amounts for each test of record for the limiting breaks. Include chemical precipitates in the response to this question. If any substitutions are made for debris surrogates (e.g., RAI 25), please provide a description of each substitution including the source term being substituted for, the surrogate, and the substituted surrogate. Include the debris source term size (e.g., fine, small) for each substitution.

**New Question 2** – It appears that the evaluation of the SBLOCA relies on the availability of such a small amount of fibrous debris that a filtering bed will not form on the strainer. Please provide a discussion on this topic. If this is the licensee's intent, please provide a justification for the assumption that a filtering bed will not form.

### **RAIs – No Response Requested**

**RAI 3** – The NRC staff had a concern that the Cal-Sil destruction testing was conducted with a relatively large (long) test target and the test nozzle was relatively small. However, upon review of the available Cal-Sil testing, it appears that 50 percent fines is a reasonable value. For example, for Ontario Power Generation, Inc. (OPG) testing, more than one-half (all outside the center of the jet impact zone) of the Cal-Sil was left on the pipe. The characterization did not count the material left on the pipe in any way when characterizing the size distribution, but only counted the insulation that was removed from the pipe. About 50 percent of the removed insulation was dust/fines (48 percent). The NRC staff has reviewed the test results and has determined that 50 percent fines and 50 percent small pieces is a reasonable characterization for debris within the approved ZOI. The response to RAI 3 is likely acceptable, but RAI 12 also relates to the amount of Cal-Sil that must be considered in the strainer evaluation. Most plants

assume that the pieces larger than fine erode to fine and transport to the strainer resulting in 100 percent Cal-Sil transport. Therefore, the response to RAI 12 regarding Cal-Sil erosion becomes important.

**RAI 5** – The NRC staff had a concern that the flow through the strainer could be greater than what the licensee considered the design flow rate because if a low-pressure safety injection (LPSI) pump fails to trip, the flow rate through the strainer is increased significantly. The FCS design flow rate did not include the potential flow from the LPSI pump. OPPD has provided information that shows that the flow from an LPSI pump that fails to trip can be stopped or throttled from the control room in a relative short time frame. These steps are followed up by locally opening the pump breakers. The plant emergency operating procedures have been revised to ensure these steps are performed. The NRC staff has made a preliminary conclusion that these steps will likely provide reasonable assurance that the strainers will be operated in a manner that will not increase their potential for failure.

**RAI 7** – The NRC staff requested that the licensee provide justification for using a 5 percent washdown metric for fine debris when sprays are not actuated and there are no other washdown mechanisms that would significantly increase washdown. The NRC had previously considered that 10 percent is an acceptable value for washdown without sprays. OPPD stated that it was changing its transport evaluation to use the 10 percent washdown metric discussed above. This response is acceptable to the NRC.

**RAI 34** – The NRC staff requested additional information regarding the source of silicates credited for the inhibition of aluminum corrosion. The licensee stated that an updated evaluation will eliminate the credit for silicate inhibition of aluminum corrosion. The NRC staff concluded that this is likely an adequate response to RAI 34.

**RAI 37** – The NRC staff requested additional justification for the assumption that fibrous debris at FCS makes up 2.79 percent of the latent debris source term when the staff's accepted value is 15 percent. OPPD stated that it would change its evaluation to include 15 percent fiber as a portion of the latent debris source term. This response is acceptable to the NRC staff.

S. Marik

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enclosed questions by September 16, 2016. If you have any questions, please contact me at 301-415-2296 or via e-mail at [Fred.Lyon@nrc.gov](mailto:Fred.Lyon@nrc.gov).

Sincerely,

**/RA/**

Carl F. Lyon, Project Manager  
Plant Licensing Branch IV-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosure:  
Request for Additional Information

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**ADAMS Accession No.: ML16106A023**    \*\*Previously concurred    \*memo dated

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