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U S Nuclear Regulatory Commission
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11555 Rockville Pike
Rockville, Maryland 20852

Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
Renewed License Nos. DPR-42 and DPR-60

Closure for Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," for the Prairie Island Nuclear Generating Plant (TAC Nos. MC4707 and MC4708)

By letter dated September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML042360586), also known as Generic Safety Issue (GSI) 191, which requested specific plant information related to containment sump performance during a design basis accident. By letter dated May 9, 2013 (ML13129A375), Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), provided the GL 2004-02 closure plan for the Prairie Island Nuclear Generating Plant (PINGP), Units 1 and 2.

In the May 9, 2013 letter (ML13129A375), NSPM indicated that the approach to resolving GSI-191 for PINGP, Units 1 and 2, was to use Option 1 (Compliance with 10 CFR 50.46 Based on Approved Models) with the "clean-plant" criteria approach described in SECY-12-0093, "Closure Options For Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" (ML121320270), and NRC letter to the Nuclear Energy Institute (NEI) dated May 2, 2012 (ML120730181). Note, the terms "clean-plant" and "low-fiber plant" are used interchangeably.

Also in the May 9, 2013 letter (ML13129A375), NSPM committed to review and document adherence to the limitations and conditions contained in Section 4.0 of the NRC Safety Evaluation (SE) for Pressurized Water Reactor Owners Group (PWROG) Topical Report WCAP-16793-NP, Revision 2, "Evaluation of Long-Term Cooling

Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid," dated April 8, 2013 (ML13084A161).

The enclosure to this letter provides the summary of the review of the limitations and conditions of the NRC SE (ML13084A161) for WCAP-16793-NP, Revision 2, for PINGP, Units 1 and 2.

If there are any questions or if additional information is needed, please contact Mr. Dale Vincent, P.E., at 651-267-1736.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on

MAR 09 2015

Kevin Davison
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (1)

cc: Administrator, Region III, USNRC
Project Manager, PINGP, USNRC
Resident Inspector, PINGP, USNRC

ENCLOSURE

Closure for Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," for the Prairie Island Nuclear Generating Plant (TAC Nos. MC4707 and MC4708)

On April 8, 2013, the Nuclear Regulatory Commission (NRC) issued the Safety Evaluation (SE) for Pressurized Water Reactor Owners Group (PWROG) Topical Report WCAP-16793-NP, Revision 2, "Evaluation of Long-Term Cooling Considering Particulate Fibrous and Chemical Debris in the Recirculating Fluid," (ML13084A161).

Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), provides responses to each of the SE limitations and conditions with respect to the application of WCAP-16793-NP, Revision 2, (WCAP-16793) to the Prairie Island Nuclear Generating Plant (PINGP), Units 1 & 2. Note, the terms "clean-plant" and "low-fiber plant" are used interchangeably.

NRC Limitation and Condition 1:

Licensees should confirm that their plants are covered by the PWROG sponsored fuel assembly tests by confirming that the plant available hot-leg break driving head is equal to or greater than that determined as limiting in the proprietary fuel assembly tests and that flow rate is bounded by the testing. Licensees should validate that the fuel types and inlet filters in use at the plant are covered by the test program (with the exception of LTAs [Lead Test Assemblies]). Licensees should limit the amount of fibrous debris reaching the fuel inlet to that stated in Section 10 of the WCAP (15 grams per fuel assembly for a hot-leg break scenario).

Alternately, licensees may perform plant specific testing and/or evaluations to increase the debris limits on a site-specific basis. The available driving head should be calculated based on the core exit void fraction and loop flow resistance values contained in their plant design basis calculations, considering clean loop flow resistance and a range of break locations. Calculations of available driving head should account for the potential for voiding in the steam generator tubes. These tests shall evaluate the effects of increased fiber on flow to the core, and precipitation of boron during a postulated cold leg break, and the effect of p/f ratios below 1:1. The NRC staff will review plant specific evaluations, including hot- and cold-leg break scenarios, to ensure that acceptable justification for higher debris limits is provided. (Sections 3.1.2 (c), 3.1.2 (e), 3.3.1, 3.4.2, 3.8, 3.9 and 3.10 of this SE).

NSPM response:

NSPM confirms that the PINGP, Units 1 and 2, are covered by the PWROG sponsored fuel assembly tests. The NRC SE (ML13084A161), pages 70-71, stated that request for additional information (RAI) response number 18 (WCAP-16793, Appendix K) provides a method acceptable to the NRC staff for determining the available driving head. NSPM used the RAI's acceptable method to determine that the PINGP available hot-leg break driving head of 15.75 psid is greater than the 13 psid limiting value determined in the proprietary fuel assembly tests.

The SE (ML13084A161) cites WCAP-16793 maximum Emergency Core Cooling System (ECCS) flow rate at 44.5 gpm per assembly for Westinghouse plants with a hot-leg break and states the, "NRC staff concluded that the accepted test program limits are applicable to UPI [upper plenum injection] plants based on the similarity of the fuel design and the lower flow rates associated with the design of the plants" and, "the NRC staff finds using a flow rate averaged over all of the assemblies to be acceptable".

The PINGP loss of coolant accident (LOCA) analysis determined the maximum safety injection (SI) flow and Containment Spray System flow total is 4805.4 gpm. Since there are 121 fuel assemblies in each PINGP core this equates to 39.7 gpm per fuel assemblies. This is less than the bounding core inlet velocity of 44.5 gpm per fuel assemblies for a hot leg break.

PINGP uses Westinghouse 422 VANTAGE+ design fuel assemblies, with 0.422 inch outer diameter fuel rods. These fuel assemblies are bounded by the PWROG test program. WCAP-16793 describes the Fuel Assembly (FA) testing program as, "the purpose of the FA testing described in this report and the supporting test reports was to develop a bounding acceptance criteria for the mass of debris that can reach the RCS [reactor coolant system] and not impede long-term cooling flows to the core".

PINGP does not have debris grid filters. As noted in the SE (ML13084A161):

> The test report states that some fuel designs have no inlet filters (Westinghouse determined that this is applicable only to the Westinghouse 2-loop UPI plants) and that these designs are bounded by the testing conducted for fuel assemblies with inlet filters, based on the limiting flow clearances of the inlet filters. . . . The maximum hot-leg break flow for the UPI plants is significantly lower than that for the majority of PWRs [pressurized water reactors] because for the hot-leg break, the majority of the flow exits the RCS through the break instead of flowing through the core.

The SE (ML13084A161) accepts the fuel assembly test results' bounding of UPI plants without inlet filters. PINGP is a UPI plant.

The PINGP, Units 1 and 2, fibrous debris reaching the fuel inlet is calculated assuming the containment fiber volume has been limited to 2.534 cubic feet by the plant

containment debris monitoring program. The density of the fiber has been determined to be 2.4 lbm per ft^3. The fibrous debris reaching the fuel inlet is calculated as:

(2.534 ft^3)X(2.4 lbm/ft^3)X(100% transport)X(45%bypass)X(453.6 gm/lbm)/121 FA

= 10.3 gm/FA

Because the PINGP, Units 1 and 2, fiber debris is less than the 15 gm per fuel assembly limit, PINGP, Units 1 and 2, has adequate hot leg driving head to assure core cooling.

NRC Limitation and Condition 2:

Each licensee's GL 2004-02 submittal to the NRC should state the available driving head used in the evaluation of the hot-leg break scenario, the ECCS flow rates, and the results of the LOCADM calculations. Licensees should provide the type(s) of fuel and inlet filters installed in their plants, as well as the amount of fiber (gram per fuel assembly) that reaches the core. (Section 3.3.1 and 3.10 of this SE)

NSPM response:

The available driving head for the hot-leg break scenarios was developed generically, and the results were provided, per WCAP-16793, in WCAP-17057-P, Revision 1, "GSI-191 Fuel Assembly Test Report for PWROG", September 2011 (WCAP-17057), which evaluated a minimum available driving head that was acceptable for the fleet of PWRs. This value was approximately 13 psid. The PINGP available hot-leg break driving head is 15.75 psid. The ECCS flow rate, as discussed above, is 39.7 gpm per FA.

The calculation tool, LOCADM, evaluation for PINGP, Units 1 and 2, used plant-specific conditions and materials to determine a maximum cladding temperature and deposit thickness. The fuel cladding temperature and deposit thickness determined from the evaluation were compared to the conservative maximum deposition thickness of 50 mils (1,270 microns) and maximum acceptable temperature of 800°F as indicated in WCAP-16793. The final calculated deposition thickness for PINGP, Units 1 and 2, is 3.6 mils (92 microns), which is less than the recommended upper limit of 50 mils. The calculated maximum temperature of the fuel cladding during recirculation from the containment sump over the 30 days following the LOCA is calculated to be 420 °F, which is well below the recommended maximum cladding temperature of 800°F.

PINGP uses Westinghouse 422 VANTAGE+ design fuel assemblies, with 0.422 inch outer diameter fuel rods. PINGP is a Westinghouse two loop UPI plant that does not have inlet filters.

The low-fiber plant criterion from "Transmittal of GSI [Generic Safety Issue] Resolution Criteria for 'Low Fiber' Plants", Nuclear Energy Institute (NEI), dated December 22, 2011, established that PINGP, Units 1 and 2, is a low-fiber plant. The quantity of debris which reaches the core is 10.3 gm per fuel assembly.

NRC Limitation and Condition 3:

Section 3.1.4.3 of the WCAP states that alternate flow paths in the RPV were not credited. The section also states that plants may be able to credit alternate flow paths for demonstrating adequate LTCC [long term core cooling]. If a licensee chooses to take credit for alternate flow paths, such as core baffle plate holes, to justify greater than 15 grams of bypassed fiber per fuel assembly, the licensee should demonstrate, by testing or analysis, that the flow paths would be effective, that the flow holes will not become blocked with debris during a LOCA, that boron precipitation is considered, and that debris will not deposit in other locations after passing through the alternate flow path such that LTCC would be jeopardized. (Sections 3.3.1 and 3.4.2 of this SE)

NSPM response:

Alternate flow paths were not credited in determining the acceptability of the PINGP Units 1 and 2, ECCS design.

NRC Limitation and Condition 4:

Sections 3.2 and 3.3 of the WCAP provide evaluations to show that even with large blockages at the core inlet, adequate flow will enter the core to maintain LTCC. The staff recognizes that these calculations show that significant head loss can occur while maintaining adequate flow. However, the analyses have not been correlated with debris amounts. Therefore, the analyses cannot be relied upon to demonstrate adequate LTCC. (Sections 3.3.3 and 3.4 of this SE)

NSPM response:

The determination that PINGP, Units 1 and 2, has adequate LTCC was not based on the calculations of acceptable LTCC with large blockages and significant head loss. The PINGP, Unit 1 and 2, core inlet head loss is bounded by the generic evaluation and test results for low-fiber plants.

NRC Limitation and Condition 5:

In RAI Response number 18 in Reference 13, the PWROG states that numerical analyses demonstrated that, even if a large blockage occurs, decay heat removal will continue. The NRC staff's position is that a plant must maintain its debris load within the limits defined by the testing (e.g., 15 grams per assembly). Any debris amounts greater than those justified by generic testing in this WCAP must be justified on a plant-specific basis. (Sections 3.4.2 and 3.10 of this SE)

NSPM response:

The PINGP, Units 1 and 2, fibrous debris reaching the fuel inlet is 10.3 gm per fuel assembly which is less than the 15 gm/fuel assembly limit defined by testing. Thus, the PINGP, Units 1 and 2, debris amounts are justified by generic testing described in WCAP-16793 consistent with the NRC position.

NRC Limitation and Condition 6:

The fibrous debris acceptance criteria contained in the WCAP may be applied to fuel designs evaluated in the WCAP. Because new or evolving fuel designs may have different inlet fittings or grid straps that could exhibit different debris capture characteristics, licensees should evaluate fuel design changes in accordance with 10 CFR 50.59 to ensure that new designs do not impact adequate long term core cooling following a LOCA. (Section 3.4.2 of this SE)

NSPM response:

PINGP, Units 1 and 2, uses Westinghouse 422 VANTAGE+ design fuel assemblies, with 0.422 inch outer diameter fuel rods. PINGP is a Westinghouse two loop UPI plant that does not have inlet filters. The PINGP fuel design was evaluated by WCAP-16793 through reference to WCAP-17057. The NRC SE (ML13084A161) concluded that the test assembly FA array test results are representative or conservative with respect to current fuel designs that have lattices with fewer fuel rods such as the PINGP FAs. The NRC SE (ML13084A161) also concluded the testing bounds the UPI plant fuel without inlet filters.

NRC Limitation and Condition 7:

Sections 2 and 4.3 of the WCAP establish 800 degrees Fahrenheit as the acceptance limit for fuel cladding temperature after the core has been re-flooded. The NRC staff accepts a cladding temperature limit of 800 degrees Fahrenheit as the long-term cooling acceptance basis for GSI-191 considerations. Each licensee's GL 2004-02 submittal to

the NRC should state the peak cladding temperature predicted by the LOCADM analysis. If a licensee calculates a temperature that exceeds 800 degrees Fahrenheit, the licensee must submit data to justify the acceptability of the higher clad temperature. (Sections 3.2, 3.4.3, 3.4.4, and 3.10 of this SE)

NSPM response:

The peak cladding temperature calculated by the calculation tool, LOCADM, for PINGP, Units 1 and 2, is 420 °F, which is well below the acceptance criterion of 800 °F.

NRC Limitation and Condition 8:

As described in the Limitations and Conditions for WCAP-16530-NP (ADAMS Accession No. ML073520891) (Reference 21), the aluminum release rate equation used in TR WCAP-16530-NP provides a reasonable fit to the total aluminum release for the 30-day ICET tests but under-predicts the aluminum concentrations during the initial active corrosion portion of the test. Actual corrosion of aluminum coupons during the ICET 1 test, which used sodium hydroxide (NaOH), appeared to occur in two stages; active corrosion for the first half of the test followed by passivation of the aluminum during the second half of the test. Therefore, while the 30-day fit to the ICET data is reasonable, the WCAP-16530-NP-A model under-predicts aluminum release by about a factor of two during the active corrosion phase of ICET 1. This is important since the incore LOCADM chemical deposition rates can be much greater during the initial period following a LOCA, if local conditions predict boiling. As stated in WCAP16530-NP-A, to account for potentially greater amounts of aluminum during the initial days following a LOCA, a licensee's LOCADM input should apply a factor of 2 increase to the WCAP-16530-NP-A spreadsheet predicted aluminum release, not to exceed the total amount of aluminum predicted by the WCAP-16530-NP-A spreadsheet for 30 days. In other words, the total amount of aluminum released equals that predicted by the WCAP-16530-NP-A spreadsheet, but the timing of the release is accelerated. Alternately, licensees may choose to use a different method for determining aluminum release but licensees should not use an aluminum release rate equation that, when adjusted to the ICET 1 pH, under-predicts the aluminum concentrations measured during the initial 15 days of ICET 1. (Section 3.7 of this SE) (Footnote not included)

NSPM response:

The calculation tool, LOCADM, run for PINGP, Units 1 and 2, accounts for under-predicted aluminum release rate during the active corrosion phase by applying a factor of two increase to the WCAP-16530-NP-A, Revision 0, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," March 2008, spreadsheet predicted aluminum release.

NRC Limitation and Condition 9:

In the response to NRC staff RAIs, the PWROG indicated that if plant-specific refinements are made to the WCAP LOCADM base model to reduce conservatisms, the user should demonstrate that the results still adequately bound chemical product generation. If a licensee uses plant-specific refinements to the WCAP-16530-NP-A base model that reduces the chemical source term considered in the downstream analysis, the licensee should provide a technical justification that demonstrates that the refined chemical source term adequately bounds chemical product generation. This will provide the basis that the reactor vessel deposition calculations are also bounding. (Section 3.7 of this SE)

NSPM response:

No plant-specific refinements were made to the LOCADM base model to reduce conservatism for PINGP, Units 1 and 2.

NRC Limitation and Condition 10:

The WCAP states that the material with the highest insulating value that could deposit from post-LOCA coolant impurities would be sodium aluminum silicate. The WCAP recommends that a thermal conductivity of 0.11 BTU/(h-ft-°F) be used for the sodium aluminum silicate scale and for bounding calculations when there is uncertainty in the type of scale that may form. If plant-specific calculations use a less conservative thermal conductivity value for scale (i.e., greater than 0.11 BTU/(h-ft°F)), the licensee should provide a technical justification for the plant-specific thermal conductivity value. This justification should demonstrate why it is not possible to form sodium aluminum silicate or other scales with thermal conductivities less than the selected value. (Section 3.7 of this SE)

NSPM response:

The PINGP calculations for LOCADM deposition evaluation used 0.19 W/(m-°K) which is equivalent to the recommended value of 0.11 BTU/(hr-ft-°F).

NRC Limitation and Condition 11:

Licensees should demonstrate that the quantity of fibrous debris transported to the fuel inlet is less than or equal to the fibrous debris limit specified in the proprietary fuel assembly test reports and approved by this SE. Fiber quantities in excess of 15 grams per fuel assembly must be justified by the licensee. Licensees may determine the quantity of debris that passes through their strainers by (1) performing strainer bypass

testing using the plant strainer design, plant-specific debris loads, and plant-specific flow velocities, (2) relying on strainer bypass values developed through strainer bypass testing of the same vendor and same perforation size, prorated to the licensee's plant specific strainer area; approach velocity; debris types, and debris quantities, or (3 assuming that the entire quantity of fiber transported to the sump strainer passes through the sump strainer. The licensee's submittals should include the means used to determine the amount of debris that bypasses the ECCS strainer and the fiber loading expected, per fuel assembly, for the cold-leg and hot-leg break scenarios. Licensees of all operating PWRs should provide the debris loads, calculated on a fuel assembly basis, for both the hot-leg and cold-leg break cases in their GL 2004-02 responses. (Section 3.10 of this SE)

NSPM response:

As presented in response to Limitation and Condition 2 above, low-fiber plant criterion from "Transmittal of GSI Resolution Criteria for 'Low Fiber' Plants", NEI, dated December 22, 2011, established that PINGP, Units 1 and 2, is a low-fiber plant.

The PINGP, Units 1 and 2, quantity of fiber which reaches the core, calculated in accordance with the NEI low-fiber plant criteria, is 10.3 gm per fuel assembly. This value is less than the 15 gm/assembly target value. Thus, no detailed PINGP, Units 1 and 2, specific strainer performance bypass evaluations were required.

NRC Limitation and Condition 12:

Plants that can qualify a higher fiber load based on the absence of chemical deposits should ensure that tests for their conditions determine limiting head losses using particulate and fiber loads that maximize the head loss with no chemical precipitates included in the tests. (Section 3.3.1 of this SE) Note that in this case, licensees must also evaluate the other considerations discussed in Item 1 above.

NSPM response:

PINGP, Units 1 and 2, do not need to qualify a higher fiber load.

NRC Limitation and Condition 13:

Licensees should verify that the size distribution of fibrous debris used in the fuel assembly testing referenced by their plant is representative of the size distribution of fibrous debris expected downstream of the plant's ECCS strainer(s). (Section 3.4.2.1 of this SE)

NSPM response:

The size distribution of fibrous debris for PINGP, Units 1 and 2, is appropriate. For the WCAP-16793 Fuel Assembly tests, 67-87% of the fibers were shorter than 500 microns, 8%-28% were between 500 and 1000 microns, and 0%-15% were longer than 1000 microns. Bypass testing data, which determined the expected PINGP size distribution for fibrous debris downstream of the ECCS strainer, showed, for 5 of the 7 tests, 80%-84% of bypassed fibers were shorter than 500 microns; on average, 77% of bypassed fibers were shorter than 500 microns, and 23% were longer than 1000 microns. The PINGP bypass fiber sizes are slightly larger than those tested by the PWROG, but are comparable.

NRC Limitation and Condition 14:

The "Margin Calculator," referenced in References 11 and 12, has not been submitted to the NRC under formal letter, and NRC staff has not performed a detailed review of the document. Therefore, NRC staff expects licensees to base their GL 2004- 02 in-vessel effects evaluations on the information provided in the proprietary test reports and associated RAI responses (References 8, 16, 17, 11 and 12), including the conditions and limitations stated in this SE, and existing plant design-basis calculations and analyses.

NSPM response:

PINGP, Units 1 and 2, did not use the "Margin Calculator" to determine in-vessel effects. The "Margin Calculator" was available as a tool for use by the PWROG to perform a preliminary evaluation of debris effects on fuel. The PINGP, Units 1 and 2, in-vessel effects were determined based on information provided in the proprietary test reports, associated RAI response and the plant-specific design basis calculations and LOCADM analysis.