Safety Evaluation Report

Related to the License Renewal of Prairie Island Nuclear Generating Plant Units 1 and 2

Docket Nos. 50-282 and 50-306

Northern States Power Company, a Minnesota Corporation (NSPM)

United States Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

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examining the Class MC pressure retaining vessel. Both the Structures Monitoring Program and the ASME Section XI, Subsection IWE Program took corrective actions to address the leakage. In addition, the applicant provided information during a public meeting on March 2, 2009. The staff reviewed the information provided in the RAI response and during the public meeting, and discovered that borated water was coming into contact with the containment vessel during refueling outages. Due to the leakage path of borated water along the bottom of the containment vessel, the staff noted that there is a possibility that portions of the containment vessel may remain wetted after refueling outages. By letter dated March 31, 2009, the staff issued follow-up RAI B2.1.38 asking the applicant to discuss its plan for assessing the current condition of the steel containment vessel and to explain how the IWE program, or a plant specific program, will manage aging of the vessel, especially in inaccessible regions, during the period of extended operation. The staff also conducted an audit on May 28, 2009, to review related on-site documentation. As a result of the audit, the staff issued additional RAIs. The applicant responded to the RAIs and committed to inspect the containment vessel and concrete in areas exposed to leakage (Commitments 41, 42, and 44). Any indications of degradation will be entered in to the applicant's Corrective Action Program and the affects on the structural integrity of the containment will be evaluated.

Based on the applicant's responses and the commitments, OI 3.0.3.2.17-1 is closed. A detailed timeline and summary of the staff's review and closure of OI 3.0.3.2.17-1 is discussed and documented under the Structures Monitoring Program in SER Section 3.0.3.2.17. The applicant's commitment to inspect the containment vessel in an area susceptible to corrosion, along with the fact that PINGP has no current signs of containment degradation, provides assurance that the IWE and Structures Monitoring Programs will effectively manage aging of the containment vessel during the period of extended operation. The additional inspections provide assurance that either the containment has not experienced significant degradation, or existing degradation will be captured and evaluated prior to the period of extended operation.

On the basis of its review, including review of the RAI responses and the review and closure of OI 3.0.3.2.17-1, the staff confirmed that the "operating experience" program element satisfies the criterion defined in the GALL Report and in SRP-LR Section A.1.2.3.10. The staff finds this program element acceptable.

UFSAR Supplement. In LRA Section A2.4, the applicant provided the UFSAR supplement for the ASME Section XI, Subsection IWE Program. The staff reviewed this section and determined that the information in the UFSAR supplement is an adequate summary description of the program, as required by 10 CFR 54.21(d).

Conclusion. On the basis of its review of the applicant's ASME Section XI, Subsection IWE Program, including the applicant's response to RAI B2.1.4-1 and RAI B2.1.38-2, and the closure of Open Item 3.0.3.2.17-1, the staff finds all program elements consistent with the GALL Report. The staff concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3). The staff also reviewed the UFSAR supplement for this AMP and concludes that it provides an adequate summary description of the program, as required by 10 CFR 54.21(d).

(Evaluation of Existing Nuclear Safety-Related Concrete Structures) as recommended in the GALL Report).

During its audit and review, the staff noticed that PINGP has identified the leakage of borated water (CAP 01064513) from the Unit 1 and Unit 2 refueling cavities and through the concrete backing the liners since 1998. Leakage was fairly consistent throughout the duration of the flooding of the refueling cavity pool (average 1 gallon per hour). However, the leakage path has not been specifically identified. Therefore, the staff requested the applicant to provide the results of any root cause analyses, as well as corrective and preventive actions taken to address or correct this issue in RAI B2.1.38-2, dated November 5, 2008. In a letter dated December 5, 2008, the applicant stated that the condition was detected by the ASME Section XI, Subsection IWE Program while examining the Class MC pressure retaining vessel. Both programs took corrective action to address the leakage. The staff reviewed the applicant's responses to the RAI B2.1.38-2. The staff found that:

- The leakage inside containment was first documented in 1998 during the Unit 2 refueling outage with water observed entering sump B from cracks in the grout around the RHR suction penetration sleeves at elevation 694 feet10 inches. This area is grouted from the floor of the sump to the ceiling of the sump back to the containment vessel wall.
- The chemical analysis of the fluid determined it to be similar to refueling water with a boron concentration of 2700 ppm, chloride concentration of 7 ppm, sulfate concentration of 0.2 ppm, and pH of 7.8. The boron content of the refueling pool water was measured at 2700 ppm with a pH of 5.2. (The increase in pH from the refueling cavity water to that found at the leaks was attributed to the acidity being neutralized by the carbonates and other minerals in the concrete.)
- The grout at sump B was removed to inspect the containment vessel wall revealing no degradation of the containment vessel.
- Other potential sources of leakage such as the Reactor Coolant (RC), Safety Injection (SI), and Residual Heat Removal (RH) systems were investigated and no other feasible source of leakage was identified.
- During the Unit 2 outage in 2008, the plant performed over 150 ultrasonic (UT) thickness readings of the containment vessel from its exterior surface in the vicinity of the fuel transfer tube and at the sump B location. All readings were found to exceed the nominal vessel plate thicknesses of 1 ½ inches and 3 ½ inches.

The staff also found that the diagram on page four of Enclosure 3 to the letter dated December 5, 2008, indicates that the potential leakage path follows the bottom of the containment liner. It appears to the staff that water could accumulate at the bottom of the liner and the area could remain wetted after refueling outages. Therefore, the staff did not agree with the applicant's conclusion that the steel liner was not constantly wetted for long periods of time by the boric acid solution to cause any deterioration of the steel surface. The staff requested the applicant to explain in greater detail the increase in pH from the borated refueling water (pH 5.2) to the leakage found in sump B (pH 7.8), the chemical properties of the "white deposit" found on the concrete surfaces and the possibility of calcium hydroxide $Ca(OH)_2$ leaching from the concrete, and why this leakage was omitted from the IWE Operating Experience discussion in the LRA.

The applicant's response explained that they did not plan to remove concrete from the 695' elevation because it is not known whether or not that area is wetted by the leakage. Instead the applicant explained that they had previously removed grout along the vessel in the RHR suction sump (Sump B). This location is at a lower elevation and consistently shows wetting when refueling cavity leakage occurs. Visual and UT inspections of the vessel at Sump B showed no signs of degradation.

The staff reviewed the response and found that removal of concrete at the 695' elevation was unnecessary. Since there is no guarantee that leaking water is contacting the vessel at the 695' elevation, the location has a low potential for corrosion. Sumps B and C are more likely to experience corrosion due to the possibility of trapped water at Sump C, and repeated wetting and relatively close ambient oxygen at Sump B. Therefore, these locations are better candidates for vessel inspections and concrete does not need to be removed at the 695' elevation.

(C) The staff requested an explanation of the upper bound containment loss estimate of 0.25" over a 36 year period and how this loss would impact the stresses in the vessel.

The applicant's response explained that the predicted 0.25" value assumes continuous wetting with aerated, concentrated boric acid over a 36 year period. However, it did not clearly explain how this estimate is related to the actual degradation, or how the design basis was being met if some or all of the estimated degradation had occurred. To address this, the applicant supplemented their response. The supplement explained that the 0.25" was a theoretical upper bound estimate that was not based on observed degradation at PINGP. The response further explained that currently there is no known containment wall thinning at PINGP. The applicant explained that if thinning is identified in the future, the issue will be entered into the Corrective Action Program and any required ASME Section XI, Subsection IWE actions would be performed and if necessary the resulting containment stresses would be analyzed.

The staff reviewed the response and concludes that the applicant has adequately addressed the corrosion estimate and the possible impacts on the containment. The absence of degradation at PINGP indicates that the 0.25" estimate is not representative of what is actually occurring in the field. In addition, the inspections committed to by the applicant provide assurance that degradation has either not occurred, or will be detected and addressed prior to the period of extended operation. Any degradation discovered in the future will be reviewed per the requirements of ASME Section XI, Subsection IWE, and the structural impact on the containment vessel will be evaluated.

(D) To account for concrete aggregate differences, the applicant assumed a concrete degradation rate twice that was used previously for Salem and Connecticut Yankee plants. The staff asked the applicant to explain whether or not any tests had been performed to confirm the assumption.

The applicant's response explained that degradation in the concrete when exposed to boric acid is directly related to the amount of cement and soluble aggregate present in the concrete. The concrete at both the Salem and Connecticut Yankee plants did not

excavation of Sump C, and enter any observed degradation into the Corrective Action Program.

The staff reviewed the response and disagrees with the applicant's estimate of reinforcement exposure time as one year. Reinforcement located near the bottom of the vessel may have been continuously exposed to borated water since refueling cavity leakage began. However, the reinforcement inspections committed to by the applicant will provide assurance that degradation has either not occurred, or will be detected and addressed prior to the period of extended operation. Therefore, the staff concludes that the applicant has adequately addressed the possibility of reinforcement corrosion.

(G) An applicant document estimated the upper bound loss of concrete depth behind the refueling cavity liner as 0.31 inches. The staff requested the applicant to address how this loss of concrete behind the liner would affect the load carrying capacity of the liner.

The applicant's response explained that the liner is effectively a membrane backed by concrete which is generally four to five feet thick. Therefore, the impact on the capacity would be negligible. The response further stated that large areas of washout are unlikely, but if they did occur behind the liner, the liner would not be expected to fail due to the ductile nature of stainless steel. In the supplemental response, the applicant stated that visual inspections and vacuum box testing of the liner plate seams will be performed in the refueling cavity to look for depressions in the liner and for signs of washout due to the cavity leakage. These inspections will be performed during the next refueling outage for both Units.

The staff reviewed the response and finds that any loss of load carrying capacity of the concrete would be negligible since the concrete sections are four to five feet thick. The staff does not agree that the possible deformation of the liner would not be an issue due to the ductility of stainless steel; however, the visual inspections of the liner plate and vacuum box testing of the liner plate seams will provide assurance that any deformation will be detected and addressed prior to the period of extended operation.

(H) The applicant committed to inspecting areas where reactor cavity leakage has been observed in the two refueling outages after implementing the proposed fix. The staff requested the applicant to explain which AMP would be used to address these inspections.

The applicant's response explained that the inspections are special inspections assigned within the Corrective Action Program, which will use the methodology, documentation and acceptance criteria of the Structures Monitoring Program. After the special inspections, general monitoring within containment will continue in accordance with the Structures Monitoring Program and the ASME Section XI, Subsection IWE Program.

The staff reviewed the response and finds it acceptable. The Structures Monitoring Program is the appropriate AMP for internal containment structures according to the GALL Report. Additionally, the GALL Report calls out the IWE AMP for inspections of the containment vessel and its integral attachments during the period of extended operation.

APPENDIX A: PINGP LICENSE RENEWAL COMMITMENTS			
41	During the first refueling outage following refueling cavity leak repairs in each Unit (scheduled for refueling outages 1R26 and 2R26), concrete will be removed from the Sump C pit to expose an area of the containment vessel bottom head. Visual examination and ultrasonic thickness measurement will be performed on the portions of the containment vessels exposed by the excavations. An assessment of the condition of exposed concrete and rebar will also be performed. Petrographic examination will be performed on sample pieces of the removed concrete if the removal method provides pieces suitable for examination. Degradation observed in the exposed containment vessel, concrete or rebar, or as a result of petrographic examination of concrete samples, will be entered into the Corrective Action Program, and evaluated for impact on structural integrity and identification of additional actions that may be warranted. [Added in letter dated 4/6/09 in response to Follow Up RAI B2.1.38] [Revised in letter dated 8/7/09 in response to a follow-up question from a conference call on 7/22/09]	B2.1.38	U1 - 8/9/2013 U2 - 10/29/2014
42	During the two consecutive refueling outages following refueling cavity leak repairs in each Unit (scheduled for refueling outages 1R26 and 2R26), visual inspections will be performed of the areas where reactor cavity leakage had been observed previously to confirm that leakage has been resolved. The inspection results will be documented. If refueling cavity leakage is again identified, the issue will be entered into the Corrective Action Program and evaluated for identification of additional actions to mitigate leakage and monitor the condition of the containment vessel and internal structures. [Added in letter dated 4/6/09 in response to Follow Up RAI B2.1.38]	B2.1.38	U1 - 8/9/2013 U2 - 10/29/2014
43	Preventive maintenance requirements will be implemented to require periodic replacement of rubber flexible hoses in the Diesel Generators and Support System and in the 122 Diesel Driven Fire Pump that are exposed to fuel oil or lubricating oil internal environments. [Added in letter dated 4/6/09 in response to RAI 3.3.2-8-1] [Revised in letter dated 6/5/09]	Table 3.3.2-8	U1 - 8/9/2013 U2 - 10/29/2014

APPENDIX A: PINGP LICENSE RENEWAL COMMITMENTS			
44	During the first refueling outage following refueling cavity leak repairs in each Unit (scheduled for refueling outages 1R26 and 2R26), a concrete sample will be obtained from a location known to have been wetted by borated water leakage from the refueling cavity. These concrete samples (one per Unit) will be tested for compression strength and will be subjected to petrographic examination to assess the degradation, if any, resulting from borated water exposure. Degradation identified as a result of the testing and examination of the concrete samples will be entered into the Corrective Action Program, and evaluated for impact on structural integrity and identification of additional actions that may be warranted. [Added in letter dated 8/7/09 in response to a follow-up question from a conference call on 7/22/09.]	U1 - 8/9/2013 U2 - 10/29/2014	B2.1.38