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Prairie Island Nuclear Generating Plant
1717 Wakonade Dr. East • Welch MN 55089

May 10, 2002

U S Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos. 50-282 License Nos. DPR-42
50-306 DPR-60

Prairie Island Nuclear Generating Plant Response to Draft NRR Position on TIA 2001-02, "Design Basis Assumptions for Non-Seismic Piping Failure" (TAC Nos. MB1402 and MB1403)

By letter dated March 18, 2002, Prairie Island requested a meeting with the NRC staff to discuss the subject TIA and TIA 2001-04. The meeting was conducted on April 12, 2002. In this meeting we agreed to submit to the NRC our comments on the draft NRR staff position on TIA 2001-02 and TIA 2001-04. The attachment to this letter is our detailed comments on the draft NRR staff position on TIA 2001-02.

In this letter we have made no new Nuclear Regulatory Commission commitments. Actions noted under Future Enhancements in the attached response are considered voluntary. Please contact Jeff Kivi (651-388-1121) if you have any questions related to this letter.

Mano K. Nazar
Site Vice President
Prairie Island Nuclear Generating Plant

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c: Regional Administrator - Region III, NRC
Senior Resident Inspector, NRC
NRR Project Manager, NRC

Attachment

Attachment

May 10, 2002

Prairie Island Response to Draft NRR Position on TIA 2001-02
"Design Basis Assumptions for Non-Seismic Piping Failure"

The concern addressed in the draft NRR staff response to TIA 2001-02 is that there is no automatic isolation between the seismic and non-seismic portions of the Cooling Water (CL) system in a seismic event.

A similar concern (from TIA 2001-04) is included in the response to this letter as it is more closely related to the issue in this TIA than the other issue in TIA 2001-04. Specifically, this issue is that the CL return headers are credited as a flow path as part of the resolution to Unresolved Safety Issue (USI) A-46. The return headers in the Turbine Building are not seismically qualified.

In the draft NRR position on the TIAs, our understanding of the NRC position can be summarized as follows:

- For the issue from TIA 2001-02, the staff position is that critical components must be able to perform their safety function assuming the complete rupture of non-Class I piping during a design bases earthquake (DBE).
- For the issue from TIA 2001-04, the staff position is that it is necessary to demonstrate seismic adequacy of the CL return header piping using licensing basis criteria or some other criteria proposed by the licensee.

This letter addresses the draft NRC responses within the context of the plant's licensing basis. In addition, a discussion of the relative significance is also included. This letter also includes a discussion of the actions that we intend to take to enhance the design margins in the system.

I. Licensing Basis

The plant is currently operating within the licensing basis. This is based on the Final Safety Analysis Report (FSAR) and other docketed correspondence, discussed in more detail in our letter dated September 17, 2001. For example, Atomic Energy Commission (AEC) letter dated February 27, 1974 (attached to our letter, dated 9/17/01) clearly acknowledges that the non-essential loads are not automatically isolated from the safeguards supply header. Also, and as discussed above, the FSAR (text, system drawings and tables showing system classifications) clearly identify that these non-seismically designed lines are not isolated from the seismically designed lines (i.e., the drawings show the classification boundaries at normally open manual valves). Neither the FSAR nor other licensing correspondence required an assumption that these lines are broken, nor did they require hydraulic analyses to determine the affects of these broken lines on the capability of the Cooling Water system. The lack of stress analyses of the non-qualified piping lines does not imply that these lines will necessarily rupture in a seismic event. In fact, there is abundant experience data that shows that non-Class I welded steel piping does not fail in large earthquakes; this is discussed in more detail below.

In the draft response to TIA 2001-02 the staff cites FSAR, Appendix B, "Special Design Procedures" as a basis for indicating that it is within the design basis for Prairie Island to assume the complete rupture of non-Class I piping during a Safe Shutdown Earthquake (SSE). However, this is not consistent with the other design and licensing bases information for the Cooling Water System. It is our contention that the FSAR should be taken as a whole; that any single statement needs to be taken in the context of the entire document. For example, the same FSAR section (Appendix B, Section B.7.2) that is cited as indicating that the lines should be assumed to rupture describes the requirements for analyzing Class I piping with connected non-Class I piping. Section B.7.2.(a) states that "Class I piping is isolated by structural or equipment anchors from piping for which Class I analysis is not required". Note that the FSAR does not require normally closed manual isolation valves or automatic isolation valves at these boundaries. FSAR, Appendix B, Table B.2-1, states that the Cooling Water System is Class I "Up to Class I Isolation Valves" and Class III for "All that is not Class I". The system flow diagrams contained in the FSAR clearly show that these isolation valves are normally open. As noted above, the AEC recognized, in docketed correspondence, that these non-essential loads were not automatically isolated.

Furthermore, the draft response to TIA 2001-02 indicates that criteria used during the licensing of Prairie Island are consistent with that used in Regulatory Guide (RG) 1.29. However, there is no evidence that the criteria in RG 1.29 or Safety Guide 29 were used or that this guidance document was a consideration in the licensing of Prairie Island. Furthermore, as correctly noted in the first paragraph of the NRR draft response,

> "the licensing application for Prairie Island was reviewed by the NRC before the SRP and RG 1.29 criteria were implemented. Therefore, these criteria (including BTP MEB 3-1) do not apply to Prairie Island."

The current wording in the draft TIA response could leave the impression that the criteria in RG 1.29 should be used to determine if the design of SSCs at Prairie Island are acceptable. As this guidance is not part of the Prairie Island licensing basis, this statement should be deleted.

Regarding the question pertaining to use of UBC Zone I loadings, the draft response to TIA 2001-02 indicates that for a piping system to be considered seismically qualified it needs to be designed for SSE loading. However, it is important to recognize that for seismic II/I design, the licensing basis is to analyze the lower class item to (at least) UBC Zone 1 earthquake load. Specifically, the AEC Safety Evaluation Report (SER), Section 3.2, "Classification of Structures, Components and Systems," states:

> "The applicant has used two categories of seismic design. Class I (seismic) items are designed to withstand the design basis earthquake (horizontal ground acceleration of 0.12g) without loss of function. Class II (seismic) items are designed in accordance with earthquake loads specified by the Uniform Building Code (UBC) for the Zone 1 area, although the code specifies the location of the site to be in a Zone 0 earthquake area (which would require less stringent design measures). The earthquake load for UBC Zone 1 is approximately equivalent to an operational basis earthquake load (horizontal ground acceleration of 0.06g). The design assures that a failure of an adjacent lower class structure due to earthquake, tornado winds or missile will not cause a loss of function to a Class I (seismic) structure or Class I (seismic) equipment by direct or indirect failure of structural components."

In these cases, it is acceptable to use UBC Zone I loadings to show that non-Class I structures, systems and components (SSCs) will not adversely affect Class I SSCs during a DBE.

With regard to the seismic adequacy of the return headers, the draft NRC response to TIA 2001-04 indicates that the expectation of the staff is that, for the purposes of resolving USI A-46, all piping credited as a flow path within a system credited for safe shutdown should be demonstrated to be functional during a SSE. This expectation appears to be inconsistent with NRC Generic Letter (GL) 87-02, the (Generic Implementing Procedure) GIP and the NRC SER that closed out USI A-46 for Prairie Island.

The scope of the USI A-46 effort is limited to equipment and the piping is specifically excluded (per NUREG 1211 and GL 87-02). For the purposes of resolving USI A-46, equipment necessary to achieve safe shutdown in a seismic event is identified. Some of the documents use the term 'path'; but as defined above the scope is equipment (i.e., piping is not within the scope). Non-safety related equipment (such as valves, heat exchangers and tanks) can be credited as part of the safe shutdown equipment list. These non-safety related components are often installed on non-safety related piping systems. Although NUREG 1211 provides the rationale for excluding piping and pipe supports in accident mitigation systems, the data cited in NUREG 1211 comes from non-safety related piping performance in actual seismic events in commercial facilities (oil refineries, fossil generating plants, etc.). Thus, it is reasonable to conclude that, contrary to the assertion in the draft response to TIA 2001-04, the NRC staff who wrote GL 87-02 and SSER No. 2 recognized the seismic adequacy of non-seismically designed piping within the safe shutdown systems selected for resolution of USI A-46 and did not require these lines to be evaluated.

II. Significance

As discussed above, it is not within the plant's licensing basis to require the assumption that the non-seismically qualified piping rupture during a seismic event. However, it is considered prudent to assess the seismic adequacy of the non-Class I piping. The following discussion provides an assessment of the seismic adequacy of the subject piping in addition to a discussion of the risk significance of the event.

1. Evaluation of Piping Ruggedness

a. Experience

As discussed above, there is abundant experience data that shows that non-Class I welded steel piping performs very well in large earthquakes. For example,

NUREG 1061, Volume 2, Addendum, summarizes reports of damage caused by actual earthquakes. This report states:

> "...welded steel piping has suffered no significant damage at numerous California industrial and power facilities that have experienced peak ground accelerations equal to or exceeding 0.5g."

Furthermore, NUREG 1061, Volume 2, Addendum, concludes:

> "The amount of piping failures observed was a very small percentage (much less than 0.01 percent) of the piping at potential risk. This leads to the first general conclusion that failure of piping in earthquakes is caused primarily by local conditions of weakness in the piping systems rather than global conditions of piping design or installation."

This piping was installed in commercial facilities and, in most cases, the piping was designed to no or minimal seismic criteria. This and other abundant documentation of piping experience provides reasonable assurance that the non-seismically designed piping will not lose its pressure boundary integrity in a seismic event.

Furthermore, this experience with actual seismic events indicates that potential vulnerabilities in non-seismic piping can be identified through system inspections, and potential vulnerabilities can be resolved through either specific component analyses or modifications.

b. Plant Specific Evaluation

As part of the work to resolve this concern, an independent seismic expert performed a preliminary assessment of the non-seismically qualified portions of the CL system. This assessment was performed based on Seismic Experience. The purpose of this assessment was to identify system vulnerabilities to a seismic event and to determine the scope of effort required to use a seismic experience based approach to demonstrate the seismic adequacy of the piping. The results from the assessment are documented in report "Preliminary Seismic Review of Non-Safety Related Portions of the Cooling Water System of Prairie Island Nuclear Generating Plant."

Overall, the assessment concluded that the piping would maintain the pressure boundary integrity during a seismic event. There were specific locations identified during the assessment that could be questionable. These specific locations will be referred to as potential vulnerabilities. These potential vulnerabilities involve rod hung unit coolers where the piping does not have a lot of flexibility and a few non-ductile joints.

The CL system hydraulic model was then used to address the significance of these potential vulnerabilities. The response of the system during a seismic event was modeled including postulating complete pipe breaks at these vulnerable locations. The results from the hydraulic model show, with breaks at these locations, that the system would still be able to accomplish the required functions to support safe shutdown for both units.

2. Risk Significance

Based on the NUREG 1488 revised Lawrence Livermore National Laboratory (LLNL) Seismic Hazard Estimates for Prairie Island, the mean 10,000 year event frequency corresponding to the 0.12g DBE is approximately 1E-4 per year. In addition to the event frequency, the other part of the equation is the probability of pipe rupture. As discussed above, the preliminary seismic review assessment identified specific potential vulnerabilities with the non-Class 1 portion of the service water system. The issues noted were primarily related to displacement of piping anchor points. Several area coolers are rod hung and respond in a seismic event as a pendulum, thus imparting anchor point motion on the attached small diameter piping. As documented in NUREG 1061, Electric Power Research Institute (EPRI) NP-5617, General Electric (GE) Topical Report NEDC-31858P (Boiling Water Reactor Owners Group (BWROG) Report for Increasing MSIV Leakage Limits and Elimination of Leakage Control Systems, Revision 2) and other reports documenting the performance of piping systems in earthquakes, the piping failures that have occurred in strong motion earthquakes have been primarily related to excessive anchor motion that the piping was unable to accommodate. Thus, the emphasis on evaluating the existing systems should be on anchor motion.

With regards to seismic anchor motion that could be encountered at Prairie Island, the DBE spectral shape is defined by a Housner spectrum derived primarily from Western U.S. type earthquakes that are characterized by large ground motion displacements that produce low frequency amplification of peak ground acceleration (pga). The Central and Eastern U.S. earthquakes are typically characterized by small amplitude ground displacements that produce high frequency amplification of peak ground acceleration. Peak ground acceleration is thus, not a good prediction of potential for damage to low frequency piping and equipment. At very low frequencies, such as would occur with the rod-hung coolers, the amplified spectral displacement in the structures is approximately equivalent to the amplified spectral displacement of the ground motion. As an example, the ground motion spectral displacement at 5% damping at 0.5 Hz is about 2.3 inches. The same value for spectral displacement is derived from the in-structure response spectra at elevation 755 feet in the auxiliary building. Spectral displacement, Sd, is derived from spectral acceleration, Sa, by the relationship:

$Sd = Sa/\omega^2$ where ω is the circular frequency.

In order to illustrate the inherent margin in the existing system, a comparison of spectral displacements is made between the Prairie Island DBE and a Uniform Hazard Spectrum (UHS) derived by LLNL for Prairie Island. LLNL and EPRI Uniform Hazard Spectra were used in IPEEE Seismic PRAs of many plants and are considered more realistic for assessing risk than the deterministic design spectra, that in most cases do not resemble ground motion spectra developed in later more state of the art probabilistic hazard studies.

The DBE for Prairie Island is defined as a 0.12g Housner spectrum. The LLNL revised hazard studies in NUREG 1488 contain UHS for Prairie Island. In IPEEE, the mean UHS was recommended for use in determining a point estimate of seismic induced failure. The mean 10,000 year return period pga from NUREG 1488 is 0.12 g for Prairie Island, corresponding to the 0.12g DBE. The UHS has higher spectral accelerations than the DBE spectrum at higher frequencies, but exhibits much lower spectral displacement. Figure 1 compares the 5% damped PING DBE spectral accelerations to the 5% damped NUREG 1488 UHS spectral accelerations. At 5 Hz and above the UHS spectral acceleration is significantly higher than the DBE spectral acceleration, however the associated displacements are very small. Figure 2 plots the spectral displacement derived from the two ground motion acceleration spectra. At 1 Hz, the spectral displacement for the DBE is about three times that of the NUREG 1488 UHS. LLNL and EPRI did not define the UHS below 1 Hz; therefore a direct comparison cannot be made below this value. The very low frequency range of the DBE, at less than about 0.2 Hz, results in a maximum of about 6 inches of amplified spectral displacement. We don't expect any systems to be below 0.5Hz where the spectral displacement of the DBE is about 2.3 inches. The UHS, if extended below 1 Hz, would result in significantly less spectral displacement than this.

It can be concluded that the existing system is at low risk due to the fact that the DBE pga for Prairie Island corresponds to a 10,000 year NUREG 1488 mean UHS plus the fact that the displacements associated with the

UHS are significantly smaller than for the DBE and could be reasonably accommodated by piping attached to low frequency equipment.

Piping systems not supported laterally for earthquakes typically have fundamental frequencies greater than 0.5Hz. The spectral displacement for the DBE at 0.5Hz is about 2.3 inches and would be expected to be 1/3 or less of this value for the NUREG 1488 UHS. Thus, lateral displacements of long unsupported spans of piping are realistically expected to displace less than 1.0 inch which can easily be accommodate in flexible piping with low frequency.

3. Operator Response

This following discussion of operator actions is provided to indicate the additional mitigation measures that are provided. However, per the results of the hydraulic model (described above), in this event, these actions are not required to ensure the CL system is available to support safe shutdown of both units.

There is procedural guidance that specifically directs operators to reduce CL System demand in the event that the flow demand is greater than the limit for continuous pump operation. In the event of a reactor trip, the first procedure entered is E-0, Reactor Trip or Safety Injection. Without a SI signal, the operators transition to ES-0.1, Reactor Trip Recovery, in the fourth step of E-0. In the fifth step of ES-0.1, the operators check the status of the CL System. If the pressure in the CL header is less than 75 psig (which the hydraulic model predicts it will be less than 75 psig with these assumed breaks) the operator is directed to reduce CL System demand per the applicable operating procedure. In addition, there is a low header pressure alarm (setpoint of 75 psig) on the Control Board which the associated alarm response procedure directs the operator to the same procedure to reduce the demand on the system.

These same procedures direct the operators to inspect the CL system for leaks. The specific areas to inspect are identified, including the isolation valve (by number and location) for isolating any piping leaks. Although not credited in the above noted hydraulic evaluations, there is assurance that these actions would be effective in locating and isolating any failed piping.

III. Future Enhancements

As discussed above, the plant is operating within its licensing basis. However, our objective is to enhance the design margin of the plant. In this specific case, to enhance the margin in the CL system, we are intending to use Seismic Margins Methodology, as defined in EPRI NP-6041 SL, to demonstrate the seismic adequacy of this non-seismically analyzed piping. The Seismic Margins Screening Criteria are based primarily on seismic experience, but specific criteria are also contained for evaluation of piping that does not meet the screening guidelines. The screening walkdowns will also utilize more detailed screening criteria that are an enhancement of the more general guidelines in EPRI NP-6041. The objective is to provide a high assurance that the piping will maintain pressure boundary integrity in a seismic event. It is not the objective to qualify the piping as Class I. This Seismic Margins approach will be used for the piping that is the subject of this TIA and the Cooling Water System return headers that are the subject of the first issue of TIA 2001-04.

The general approach will be to perform walkdown assessments of the non-seismic piping to identify piping and equipment items that could be potentially vulnerable to seismic induced loads. Potential vulnerabilities identified during these assessments will be resolved either through analysis, hardware modification or evaluating the system response using hydraulic modeling analysis assuming breaks at these potential vulnerabilities.

IV. Conclusions

In conclusion, the plant is operating within the licensing basis. An assessment shows that this issue is not significant from a risk perspective. Based on industry experience and the actual robustness built into the system, there is reasonable assurance (with the exception of a few specific potentially vulnerable locations) that the piping will maintain the pressure boundary integrity during a seismic event. Hydraulic evaluations show that the system can support safe shutdown of both units with postulating breaks at these potentially vulnerable locations. In addition, enhancements are planned to increase the margin of the system.

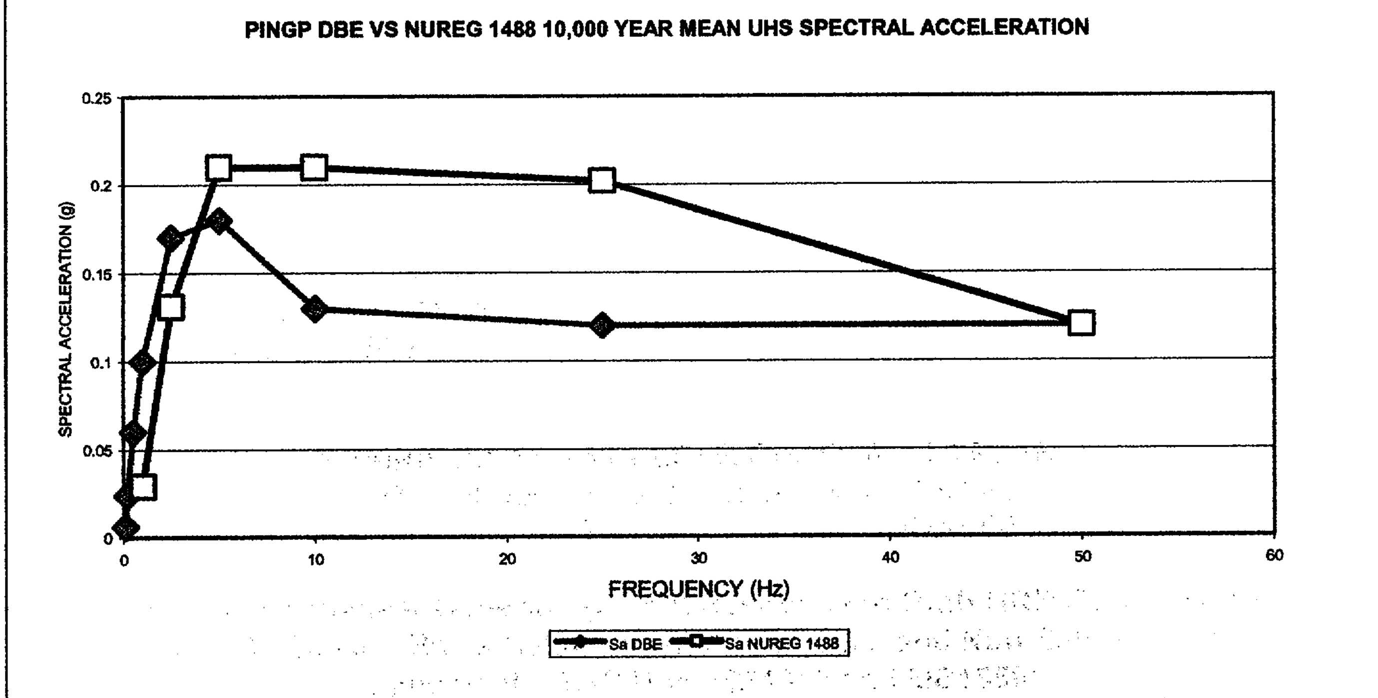

Figure 1

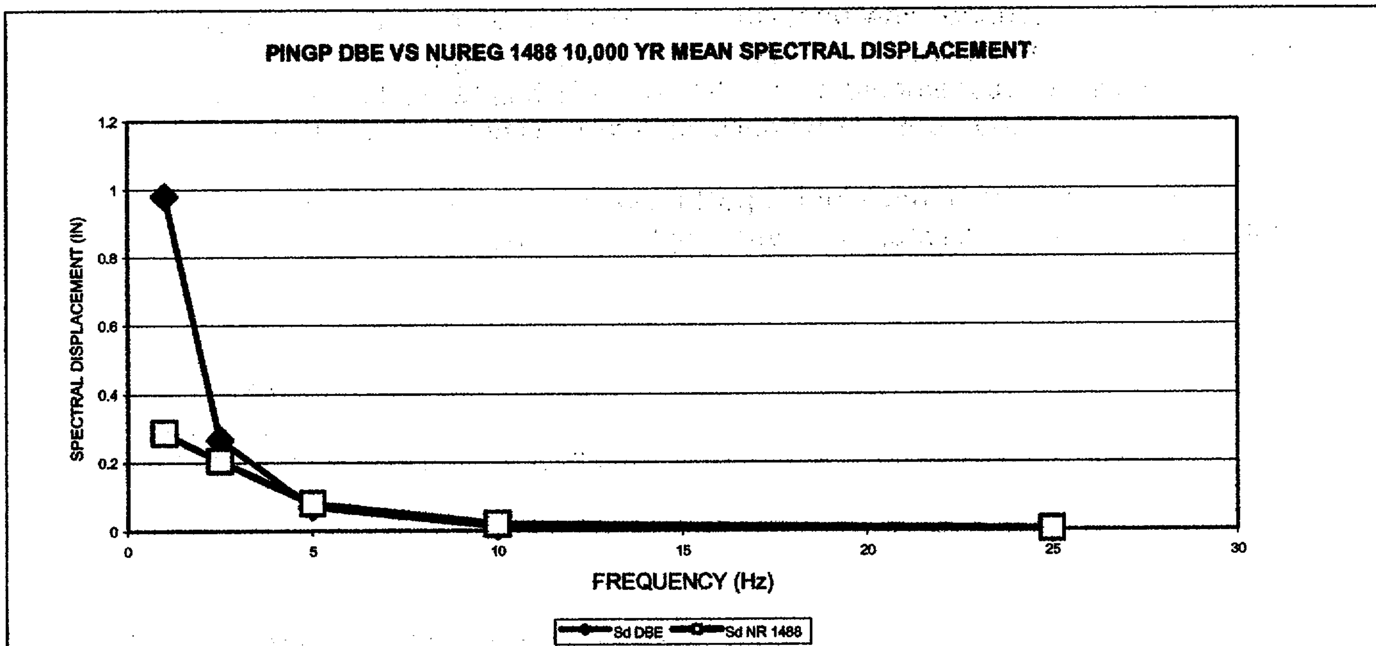

Figure 2