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SUBJECT: Responds to RAI re seismic analysis of RWST for resolution USI A-46.Discussion of calculation results,copy of calculations & relevant drawings of RWST & lateral support structure encl.

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NRC-97-87

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August 15, 1997

U.S. Nuclear Regulatory Commission
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Ladies/Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Response to Request for Additional Information Regarding the Seismic Analysis of the RWST for Resolution of USI A-46

References: 1) Letter from Richard J. Laufer (NRC) to M.L. Marchi (WPSC), "Request for Additional Information Related to the Resolution of Unresolved Safety Issue (USI) A-46 - Kewaunee Nuclear Power Plant," dated May 7, 1997.

2) Letter from C.R. Steinhardt (WPSC) to NRC Document Control Desk, "Response to Request for Additional Information for Resolution of USI A-46 at the Kewaunee Nuclear Power Plant," dated July 11, 1997.

3) Letter from C.R. Steinhardt (WPSC) to NRC Document Control Desk, "Response to Request for Additional Information Regarding the Summary Report for Resolution of USI A-46," dated December 20, 1996.

4) EPRI NP-6041-SL, Revision 1, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," Electric Power Research Institute, Palo Alto, CA, August 1991.

In reference 1, the NRC Staff requested additional information from Wisconsin Public Service Corporation (WPSC) related to the resolution of Unresolved Safety Issue (USI) A-46 at the Kewaunee Nuclear Power Plant. WPSC provided the NRC with the requested information in reference 2, and agreed to submit the results of a detailed seismic analysis of the Refueling Water Storage Tank (RWST) by August 15, 1997. This letter and attachments provide the requested information, including a discussion of the calculation results, a copy of the calculations (Attachments A & B), and relevant drawings of the RWST and lateral support structure (Attachment C).

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Drawings located in Central Files

Description of the Issue

The refueling water storage tank (RWST) was originally identified as an outlier during the Kewaunee USI A-46 walkdowns. The tank was identified as an outlier for two reasons: (1) the tank is laterally braced, and the Generic Implementation Procedure (GIP) method which calculates frequencies and responses based on a free-standing tank was not directly applicable in this case, and (2) the fluid height-to-tank radius ratio (h=69.5', r=13') slightly exceeded the upper end value of 5.0 given in Table 7-1 of the GIP. Once a tank is declared an outlier, the method of resolution is not prescribed by the GIP.

To initially address the outlier issue, an analysis of the tank was performed using the Conservative Deterministic Failure Margin (CDFM) analysis approach described in Appendix H of EPRI Report NP-6041 (Ref. 4). The initial analysis concluded that the tank CDFM capacity was 25 percent above the design basis peak ground acceleration. The analysis also predicted local buckling at the base of the tank before the tank lateral supports engaged. The Kewaunee seismic review team concluded that the buckling was acceptable in this particular case since tank displacement was strictly limited by the tank lateral supports. As a result, it was concluded that leak integrity would be maintained since the strain at the base of the tank remained in the elastic range. WPSC described the results of the initial analysis in an earlier submittal to the Staff (Ref. 3). The Staff disagreed with this conclusion, and stated in reference 1 that "buckling of the RWST is not acceptable to the NRC staff, because there is no assurance that the RWST will maintain its function after buckling." WPSC was then requested to inform the Staff of the intent to perform further analytical reviews, or to perform physical modifications to the tank to ensure that the RWST will not buckle under a safe shutdown earthquake.

To resolve the Staff's concerns, a more detailed structural analysis of the RWST was recently completed by Stevenson & Associates (S&A), the primary consultant to WPSC for the USI A-46 project. The complete detailed analysis is provided in Attachment A.

Physical Description of the RWST

The RWST is a 276,500 gal. vertical tank measuring 26 ft in diameter and 70 ft in height. The stainless steel tank is enclosed inside a reinforced concrete shield wall which measures 31 ft inside diameter. The tank is anchored at the bottom with eight (8), 1" diameter anchors. Sixteen (16) lateral supports are installed between the tank wall and concrete shield wall. Four (4) lateral supports are installed at the top of the tank (at 90 degree intervals), and four lateral supports are installed at each of three intermediate positions for a total of sixteen supports.

The lateral support brace arms are welded to tank ring girders and extend out to the reinforced concrete shield wall. Support pads are embedded in the reinforced concrete shield wall to provide a contact surface for the sides of the lateral support brace arms. A construction clearance of 1/8" was allowed between the front and rear sides of the lateral support brace arms and the front and rear faces of the support pads. It is this 1/8" gap which must close before the lateral support brace arms engage to support the tank under SSE loads.

Plan and elevation views of the RWST and lateral supports are provided in Attachment C.

Summary of the Detailed Structural Analysis

Attachment A provides the detailed RWST analysis (S&A calculation C-023), and Attachment B provides the initial RWST analysis (S&A calculation C-018, Appendix G). The detailed analysis supplements the initial analysis in several key areas to demonstrate that buckling does not occur in the tank shell under SSE loads. Although the RWST is considered an analytical outlier because it does not meet the configuration requirements of Section 7 of the GIP, the GIP guidance and acceptance criteria were followed to the extent possible, with several enhancements as described below and within the calculation. Section 7 of the GIP prescribes; "When a tank or heat exchanger fails to pass the screening guidelines, refined analyses could be performed which include the use of more realistic or accurate methods instead of the simplified, generic analysis methods used in this section and Reference 26 [EPRI NP-5228]." The detailed analysis takes the following into account:

- Tank self-weight is accounted for in the analysis. The inclusion of tank self-weight results in a decreased final rotation of the tank base. It is important to note that the effect of water hold-down forces was conservatively neglected in the detailed analysis, as it was in the initial analysis.

- Amplified floor response spectra of 4% critical damping is used in the detailed analysis, as recommended by the GIP. The initial analysis assumed 5% damping as allowed by the CDFM methodology.

- The diaphragm action of the roof is accounted for in the calculation of the stiffness of the top lateral supports.

- In the initial analysis, the tank was analyzed assuming a fixed-support condition for a free-standing tank. As a result, tank base rotation was not considered in the initial analysis. The detailed analysis takes into account the progressive tank up-lift.

- The minimum yield strength of the A-240, Type 304 stainless steel tank material was established using certified test results provided by the steel manufacturer. The actual physical properties, as determined by standard ASTM tests on specimens from the same heats, were used to determine yield strength. The minimum yield strength of 37,900 psi was used in the detailed analysis. This is considered conservative since stainless steel can be generally characterized as having no specific yield point. The material shows no flat yield plateau, and continues to show increasing stress with increased strain until its ultimate stress capacity is reached.

The detailed analysis demonstrates that the tank shell does not buckle under SSE loads. The allowable buckling stress using the GIP criteria was determined to be 9.67 ksi, which exceeds the buckling demand of 8.17 ksi. Therefore, based on the results of the detailed analysis, it can be concluded that the RWST will maintain its structural integrity during and following a SSE event. WPSC believes that the detailed analysis resolves the outlier issues associated with the RWST, and physical modification to the RWST support structure is not warranted.

Finally, a clarification should be noted in the response to NRC Question 5c of reference 3, where base shear demand was reported as 259 kips and the shear capacity was reported as 1183 kips. Actual base shear demand should have been reported as 273 kips, rather than 259 kips. The correction appears in revision 1 of S&A calculation C-018, which is provided in Attachment B. Given the large margin between base shear demand and shear capacity, the change has no effect on the conclusion of the calculation.

Please contact a member of my staff if you have any questions or require any additional information.

Sincerely,

C. R. Steinhardt
Senior Vice President - Nuclear Power

GCR

Attach.

cc - US NRC Region III (w/o attach.)
US NRC Senior Resident Inspector (w/o attach.)

Subscribed and Sworn to
Before Me This 15th Day
of August 1997

Notary Public, State of Wisconsin

My Commission Expires:
June 13, 1999