



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NOS. 166 AND 170 TO
FACILITY OPERATING LICENSE NOS. DPR-24 AND DPR-27
WISCONSIN ELECTRIC POWER COMPANY
POINT BEACH NUCLEAR PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-266 AND 50-301

1.0 INTRODUCTION

By letter dated November 9, 1995, as supplemented by letters dated November 13 and November 16, 1995, Wisconsin Electric Power Company (WEPCo, the licensee) requested an amendment to Facility Operating Licenses DPR-24 and DPR-27 for the Point Beach Nuclear Plant (PBNP), Units 1 and 2, respectively.

The request proposes an alternative repair criterion for defects found in the tube expansion region within the tubesheet of the Unit 2 steam generators (SGs). Tubes with through-wall degradation in excess of the current plugging limits could remain in service without repair provided the indications exist below a specified distance (designated F*) from the bottom of the upper roll transition region. To support the licensee's request, Babcock & Wilcox Nuclear Technologies (BWNT) completed a test program to demonstrate that the proposed F* distance satisfies the necessary structural and leakage integrity requirements of Appendix A to 10 CFR Part 50 and the plant Technical Specifications (TSs).

Surveillance requirements within the plant TSs require a periodic inspection of SG tubes for the detection of potential degradation (e.g., cracks, dents, corrosion, etc.), which could diminish the structural margins and leakage integrity of the tubes. The detection of tube degradation in excess of the Point Beach TS limits requires removal of the tube from service. The licensee has proposed a revised repair criteria that would allow SG tubes with defects to remain in service provided the defects reside a specified distance, F*, below the roll transition region. Degradation identified in a SG tube below the F* length would be allowed to remain in service without repair (e.g., sleeving). This provision is based on the results of testing which determined the minimum interference fit engagement length necessary to ensure SG tube structural and leakage integrity.

The NRC staff requested additional information from the licensee during a telephone call on November 13, 1995. The licensee submitted additional information by letters dated November 13, 1995, and November 16, 1995, in response to the staff questions. This additional information revised the proposed changes to the TSs and provided additional technical information to

support the F* repair criterion. The proposed TS changes only apply the F* criterion to the Unit 2 SGs. The staff has reviewed the information supplied by the licensee and completed an evaluation of the licensee's request to amend the Point Beach TSs to allow the F* criterion to be used.

2.0 BACKGROUND

SG tubes comprise a significant portion of the reactor coolant pressure boundary. Maintenance of this barrier is provided by the integrity of the SG tube wall and the tube to tubesheet connection. This connection is an interference fit made by roll expanding the tube into a bore through the tubesheet. The inelastically-deformed SG tube is held in place by the elastic springback of the tubesheet. The SG tubes are roll expanded from the bottom of the tubesheet and welded at the tubesheet primary face. This joint normally provides sufficient strength to maintain adequate structural and pressure boundary (leakage) integrity.

General Design Criteria 14, "Reactor Coolant Pressure Boundary," and 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," of Appendix A to 10 CFR Part 50 state the requirements applicable to maintaining adequate structural and leakage integrity for SG tubes. Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," describes a method accepted by the NRC staff for establishing the limiting safe conditions of degradation of SG tubing. Although RG 1.121 conservatively focuses on degradation in the freespan regions, the methods described apply to other tube regions, such as the roll expansion length.

In order to demonstrate adequate structural margin for SG tube degradation, an analysis must address the limiting conditions during normal operation, anticipated operational occurrences, and postulated accident conditions. The margin to failure under normal operating conditions as recommended in RG 1.121 should not be less than 3 at any tube location. Subsection NB-3225 of Section III of the ASME Boiler and Pressure Vessel Code specifies the margins of safety under postulated accident conditions.

Structural loads imposed on the SG tube-to-tubesheet connections primarily result from the differential pressure between the primary and secondary sides of the tubes. The peak postulated loading occurs during a depressurization event of the secondary side of the SG. However, normal operating loads, cyclic joint loading from major plant transients (e.g., startup and shutdown), and potential thermal expansion loads can also be significant. The analysis (BAW-10195P) supporting the licensee's proposed modification to the plant TSs addressed the limiting conditions necessary to maintain adequate integrity of the tube-to-tubesheet interference fit. Specifically, the tube must not experience excessive displacement relative to the tubesheet.

The elastic preload between the tube and tubesheet not only prevents pullout of the tube, but also provides a leaktight barrier minimizing the potential for primary-to-secondary coolant leakage. With a sufficient length of hardroll, the tube-to-tubesheet connection will not allow any leakage under normal and faulted conditions. SG tube through-wall degradation within the roll expanded joint would decrease the path length necessary for primary-to-

secondary leakage. The proposed amendment would permit such degradation to remain in service provided there exists a sufficient length of nondegraded hardroll below the bottom of the roll transition region.

Unit 2 has two Westinghouse Model 44 SGs. The NRC approved an amendment to include an F* repair criterion in the Indian Point Station Unit 2 (which also has Model 44 SGs) TSs on March 13, 1995. The licensee's proposed changes to the Point Beach TSs are similar to those approved by the NRC staff for Indian Point. However, the proposed F* distance for Point Beach is 1.12 inches rather than 1.25 inches previously approved for Indian Point Unit 2.

3.0 DISCUSSION AND EVALUATION OF THE F* DISTANCE

3.1 Testing to Determine F*

Under actual service conditions, the differential pressure acting over the cross sectional tube area provides an axial force tending to pull the tube out of the tubesheet. This axial load is counterbalanced by the frictional force between the tube and tubesheet due to the roll expanded interference fit. The primary-to-secondary differential pressure also alters the radial force between the tube and tubesheet by an expansion of the tube diameter from internal pressure and by bowing of the tubesheet. The resultant loads due to these effects will affect the frictional force between the tube and tubesheet.

To determine the necessary roll expansion joint engagement length, a series of mechanical tests were completed on simulated SG tubes. Tubes were subjected to combined internal pressure and axial loading. The test data were used in conjunction with plant-specific conditions (pressure, temperature, etc.) to calculate the acceptable hardroll length. The test program was completed previously by BWNT. Further details are provided in the staff's safety evaluation dated March 13, 1995, approving the use of the F* criterion for Indian Point, Unit 2. Using the test data and the results of calculations specific to actual and postulated loadings on the Point Beach tubes, the licensee determined the length necessary to prevent pullout of an F* tube from the tubesheet.

As part of the test program to provide the basis for the proposed F* length, tubes were subject to leak rate testing. They were internally pressurized to simulate differential pressures during normal operating and faulted conditions. The acceptance criteria for these tests specified an allowable leakage limit. Tube displacements were also monitored during the tests. Based on the test results, the licensee concluded that the leakage from an F* tube is significantly lower than the leakage requirements in the plant TSs. Thus, a nondegraded hardroll joint which meets the structural requirements for F* will also satisfy the requirements for leakage integrity.

3.2 F* Test Results

Based on the results of the leak rate and mechanical testing, the licensee determined a nominal engagement length necessary to ensure adequate margins for tube integrity. The hardroll length was adjusted to account for the limited test sample size, statistical scatter in the data, and NDE inspection

error (discussed in Section 3.4). The licensee has proposed that tubes with degradation in the roll expanded region can remain in service if all degradation lies below the F* distance, which is equal to the 1.12 inches (measured down from the bottom of the upper roll transition).

3.3 Rerolling of Steam Generator Tubes

The licensee plans to utilize a rerolling process to introduce a new hardroll into the tube above the original roll transition region. The process will create a tube-to-tubesheet joint of sufficient length to satisfy the requirements of the F* criterion. This will allow tubes with identified defects to remain in service provided a hardroll joint exists above this degradation (at a distance greater than or equal to the F* distance). The objective of the rerolling procedure is to establish a new hardroll with a nominal length of 1½ inches. Since the new hardroll will be greater than the proposed F* distance, the tube would be allowed to remain in service.

A qualification of the rerolling process was completed for Indian Point Unit 2 as part of the F* license amendment. The qualification verified that the assumptions of the F* assessment remained valid for rerolled tubesheet joints. BWNT completed an assessment to compare the assumptions in the Indian Point analysis to the conditions at Point Beach. Based on the results of their analysis, the rerolling procedure satisfies the requirements of the F* criterion.

3.4 Inspection of the F* tubes

A series of tests were completed to determine the uncertainty in the measurement of the F* distance using eddy current inspection methods. The testing included measurements of F* distances in sample tubing. Data were recorded by several analysts using both bobbin coil and motorized rotating pancake coil (MRPC) probes. The data were compared with the known F* distances to calculate the measurement error associated with each inspection. The resultant error, which was determined at a 99-percent confidence level, was incorporated as an additional length in the F* distance.

Following the rerolling of tubes with degradation identified in the original roll transition region, inspections of the new hardroll were completed to confirm the integrity of the new tube-to-tubesheet joint. Bobbin coil profilometry inspections verified that the rerolling process introduced an adequate hardroll. A rotating probe inspection using a Plus Point coil was then completed to ensure that no degradation existed within the F* distance. F* distances were obtained using data from the bobbin coil probe.

3.5 Staff Evaluation

In support of the proposed TS amendment, tests were completed to determine an acceptable F* distance. The testing utilized specimens which reflect the actual tube-to-tubesheet joint configuration within Westinghouse Model 44 SGs. Applied loads for structural assessment and leakage rate testing were specified in accordance with NRC requirements. The licensee's proposed

changes to the TSs are consistent with the conclusions from the test program to determine F*.

The rerolling procedure used in conjunction with the proposed F* criterion permits rolling of tubes in the upper half of the tubesheet. The staff was concerned that the pullout resistance provided by a hardroll in this region would be diminished during accident conditions (such as a main steam line break) by bowing of the tubesheet. The bowing effect could dilate the tubesheet holes, reducing the interference stresses between the tube and tubesheet. The staff completed an independent assessment of the bowing effect and reviewed the analysis by BWNT which addressed this phenomenon. The staff concluded that the assumptions in the F* analysis bound the anticipated reduction in strength from tubesheet bowing during accident conditions.

4.0 PROPOSED TECHNICAL SPECIFICATION CHANGES

The following summarizes the proposed changes to the TSs:

1. Proposed New TS 15.4.2.A.2(e)

The licensee will add TS 15.4.2.A.2(e) to require an inspection of all F* tubes in the F* region as part of the minimum sample size specified in TS 15.4.2.A.2(a) through (d) during each inspection. The results of the F* tube inspections are not to be used as a basis for additional inspections per Table 15.4.2-1.

2. Proposed Changes to TS 15.4.2.A.3(a)

The licensee has proposed to include in TS 15.4.2.A.3(a) a definition of the F* distance and an F* tube. The F* distance is the length of the expanded portion of a tube which provides sufficient nondegraded tube expansion to resist pullout from the tubesheet. The F* distance is 1.12 inches and is measured down from the bottom of the upper roll transition region. The definition of an F* tube is a tube with degradation below the F* distance, a depth equal to or greater than 40 percent, and not degraded within the F* distance.

3. Proposed Revision to Bases for Section 15.4.2

The bases have been revised to reflect the changes in the TSs.

The licensee has also proposed to include a note on the bottom of pages 15.4.2-2 and 15.4.2-4 of the TSs which states that the requirements for F* only apply to the Westinghouse Model 44 SGs in Unit 2. Following Unit 2 SG replacement, the requirements for F* are null and void.

5.0 SUMMARY

The licensee submitted a proposed amendment to the Point Beach TSs which would permit SG tubes to remain in service with degradation in excess of the current plugging limit, provided the degradation exists below the F* distance. The F* criterion only applies to the Unit 2 SGs and is in effect until the SGs are

replaced. The licensee evaluated a worst-case flaw present at the F* distance and concluded that the proposed changes are consistent with the NRC guidelines for developing SG tube plugging criteria. The staff has reviewed the licensee's submittals and concluded that the proposed TS changes to the SG tube surveillance requirements are acceptable.

6.0 EMERGENCY CIRCUMSTANCES

During the current Unit 2 refueling outage, the licensee submitted an exigent TS change request to reduce the reactor coolant system raw measured total flow rate limit and reflect new reactor core safety limits for Unit 2. The amendment request was necessary because of the significant number of degraded SG tubes that were discovered during the outage, and the anticipated tube repairs that would reduce to flow through the SGs. (That amendment was issued by NRC on November 17, 1995.)

While approval of that amendment request was pending, the SG inspections were completed, and the licensee determined that there were a significant number of flaw indications in unsleeved SG tubes in the tubesheet area. Point Beach TSs require that these tubes be repaired by an approved technique or plugged. The licensee then determined that the most prudent repair technique for most of the tubesheet area indications would be to reroll the tubes in accordance with the F* criterion. This criterion requires NRC approval prior to implementation.

The licensee completed its analysis in a timely manner, submitting the TS change request on November 9, 1995, and requesting emergency processing so that plant startup would not be delayed. Throughout this process, the licensee acted promptly and kept the staff informed regarding the status of its activities. The staff has concluded that an emergency situation exists in that failure to act in a timely manner will prevent resumption of operation, and that the licensee could not avoid this emergency situation. Therefore, pursuant to 10 CFR 50.90(a)(5), this request is being handled on an emergency basis.

7.0 BASIS FOR FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

As required by 10 CFR 50.91(a), the licensee has provided its analysis of the issue of no significant hazards consideration. The NRC staff has reviewed the licensee's analysis against the standards of 10 CFR 50.92(c). The staff's review is presented below.

The licensee analyzed the F* criterion and conducted tests in accordance with Regulatory Guide 1.121, considering design, operational, and potential accident loadings. Both tube rupture and tube pullout were considered. In addition, potential leakage allowed and effects on heat transfer capability were assessed. The analyses and testing have shown that applying the F* criterion to the SG tubes with flaw indications in the tubesheet region, and rerolling the tubes, maintains the structural integrity and heat transfer capability of the SG tubes. Therefore, operation of the facility under the proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

The analyses and tests discussed above, which were performed in accordance with Regulatory Guide 1.121, considered design, operational and accident loadings, and looked at tube rupture and pullout. Potential tube leakage and heat transfer capability were also quantified. The results of this effort demonstrated that tube integrity would be maintained. Since tube integrity is maintained, and there are no other changes to plant systems or components, and no changes to the way the plant is operated, this change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

As previously stated, tube integrity is not compromised by the application of the F* criterion. In addition, heat transfer capability and leak tightness are maintained. Further, the licensee will continue to adhere to the TS leakage limits. Since the repair process is acceptable, and the licensee is not making any other plant or operation changes, this change does not involve a significant reduction in a margin of safety.

Based upon the above considerations, the staff concludes that the amendment meets the three criteria of 10 CFR 50.92. Therefore, the staff has made a final determination that the proposed amendment does not involve a significant hazards consideration.

8.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Wisconsin State official was notified of the proposed issuance of the amendment. The State official had no comments.

9.0 ENVIRONMENTAL CONSIDERATION

These amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluent that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission made a final no significant hazards consideration finding with respect to this amendment. Accordingly, these amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR §51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of these amendments.

10.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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Date: November 22, 1995