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SUBJECT: Application for amend to license DPR-43,redefining pressure boundary for Westinghouse hybrid expansion joint sleeves.

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October 6, 1995

10 CFR 50.90

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Ladies/Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Proposed Amendment 136 to the Kewaunee Nuclear Power Plant Technical Specifications to
Redefine the Pressure Boundary for Westinghouse Hybrid Expansion Joint Sleeves

Reference: Letter from E.E. Fitzpaterick (AEP) to U.S. Nuclear Regulatory Commission dated August 4, 1995.

Wisconsin Public Service Corporation (WPSC) is submitting this proposed Technical Specification (TS) amendment to redefine the pressure boundary for Westinghouse mechanical hybrid expansion joint (HEJ) steam generator (SG) tube sleeves. The existing TS, Figure TS 4.2-1, defines the pressure boundary for the upper HEJ sleeve joint as the entire expanded region of the sleeve-to-tube attachment. In 1994 and 1995, eddy current examinations of this area detected a significant number of indications located below the upper hardroll joint yet still within the expansion region. In accordance with the TS, these SG tubes were removed from service by plugging. Subsequent analyses, evaluations and tests have shown that the geometric configuration of the sleeve-to-tube expansion and attachment continues to provide sufficient structural integrity and leakage resistance provided the elevation of the indication is below an established elevation. Many of the sleeved tubes that were plugged fall into the category of still having sufficient structural and leakage integrity.

This proposed amendment affects TS section 4.2.b, "Steam Generator Tubes". Attachment 1 contains background information, a description of the change, a safety evaluation, significant hazards determination, and environmental considerations. Attachment 2 contains the affected

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TS pages. The proposed TS changes and technical basis are the same as that proposed by American Electric Power Company (AEP) for DC Cook Unit-1. The technical supporting document, WCAP-14446, "Repair Boundary For Parent Tube Indications Within the Upper Joint Zone of Hybrid Expansion Joint (HEJ) Sleeved Tubes," was previously submitted to the NRC staff as Attachment 4 to the DC Cook Unit-1 submittal (Reference 1). Based on discussions held with NRC technical staff and representatives from Westinghouse, AEP and WPSC, we understand that additional chemistry information has been requested. Westinghouse is currently collecting the necessary data to respond to the NRC request. This additional information will be submitted later this month.

Due to the extensive SG tube plugging performed during the 1995 refueling outage, the Kewaunee Nuclear Power Plant (KNPP) is currently operating in a reduced power condition of 96.3% of full power. This condition of reduced power operation and the prospects of future power derates has a significant economic impact on the owners of KNPP; therefore, we respectfully request the NRC staff give this amendment request a high review priority. The results of the staff review will factor significantly into our fall 1996 outage plans.

In accordance with the requirements of 10CFR50.36(b), this submittal has been signed and notarized. A copy of this submittal has been transmitted to the State of Wisconsin as required by 10CFR50.91(b)(1). Please feel free to contact a member of my staff if you have questions or require additional information.

Sincerely,

C. R. Steinhardt
Senior Vice President - Nuclear Power

SLB/jmf

Attach.

cc - US NRC Region III
US NRC Senior Resident Inspector
Mr. Lanny Smith, PSCW

Subscribed and Sworn to
Before Me This 6th Day
of October 1995

Jeanne M. Ferris
Notary Public, State of Wisconsin

My Commission Expires:
June 13, 1999

ATTACHMENT 1

Letter from C. R. Steinhardt (WPSC)

To

Document Control Desk (NRC)

Dated

October 6, 1995

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INTRODUCTION

Wisconsin Public Service Corporation (WPSC) is submitting this proposed Technical Specification (TS) amendment to redefine the pressure boundary for Westinghouse mechanical hybrid expansion joint (HEJ) steam generator (SG) tube sleeves. The existing TS, Figure TS 4.2-1, defines the pressure boundary for the upper HEJ sleeve joint as the entire expanded region of the sleeve-to- tube attachment. In 1994 and 1995, eddy current examinations detected a significant number of parent tube indications (PTIs) below the upper hardroll joint yet still within the expansion region. In accordance with the TS, these SG tubes were removed from service by plugging resulting in a reduced power condition for the Kewaunee Nuclear Power Plant (KNPP). Subsequent analyses, evaluations and tests have shown that the geometric configuration of the sleeve-to-tube expansion and attachment continues to provide sufficient structural integrity and leakage resistance for a completely separated parent tube provided the elevation of the PTI is below an established elevation. Many of the sleeved tubes that were plugged fall into the category of still having sufficient structural and leakage integrity.

The proposed revision to the upper HEJ pressure boundary, as shown on Figure 1, will allow PTIs located in the upper HEJ to remain in service provided there is adequate structural and leakage integrity relative to the guidance of Regulatory Guide I.121. The proposed pressure boundary is based on analytical evaluations, the results of prototypic testing, and the results of destructive examinations and tests of HEJ specimens removed from the Kewaunee SGs in April of 1995. The culmination of these test results shows that tubes with PTIs located 1.1 inches or farther below the bottom of the hardroll upper transition (HRUT) have sufficient structural and leakage integrity and do not compromise the safety of the SG tube bundle.

The reference location for the determination of the pressure boundary, i.e. bottom of the HRUT, was selected based on ability to measure the elevation of the indications using existing eddy current probe technology. The proposed repair boundary will allow PTIs located 1.1 inches below the bottom of the HRUT and lower, with an added uncertainty factor to account for NDE measurement and variations in the physical dimension of the hardroll joint, to remain in service. This uncertainty factor will be established based on the NDE technique selected to perform the HEJ inspection.

BACKGROUND

The Kewaunee Nuclear Power Plant (KNPP) SGs have been experiencing tube wall degradation attributed to outside diameter intergranular attack and outside diameter stress corrosion cracking (ODSCC). As a result of this degradation significant tube plugging and sleeving has been required. Tube plugging initially began in 1983 as a corrective action measure. During the

1988 and 1989 outages a large scale preventative and corrective sleeving program was implemented in the hot leg tube sheet crevice region. All of the sleeves installed were Westinghouse mechanical HEJs. Additional sleeving occurred in 1991 using the Westinghouse HEJs, and in 1992 with the Combustion Engineering welded sleeves. As a result of these sleeving programs a total of 2195 HEJs and 12 CE sleeves were installed in SG A, and 2133 HEJs and 4 CE sleeves were installed in SG B.

During the 1994 refueling outage the upper HEJs were inspected using the I-coil, a motorized rotating pancake coil (MRPC) probe developed for sleeved tube inspections. A total of 77 circumferential crack-like indications were detected in the parent tube, i.e. PTIs. Sixty-six of the indications were within the repair boundary limit as defined on Figure TS 4.2-1, and were removed from service by plugging the tubes. The remaining 11 indications were located below the upper joint repair boundary limit. In 1995, the upper HEJs were examined with the MRPC Plus-Point Probe. During this inspection 753 PTIs were detected; 657 in the TS defined repair boundary limit and 92 below the repair boundary limit. The 657 PTIs located within the defined pressure boundary were removed from service by plugging the tubes, and three HEJ specimens were removed for testing and destructive evaluation.

When the PTIs were first detected in 1994, analysis and prototypic testing were performed to characterize the effect of the degradation on the structural and leakage integrity of the upper joint. Wisconsin Public Service Corporation (WPSC) presented this information to the NRC staff in April of 1994 as a basis to revise the TS repair criteria. The NRC staff responded that they would have insufficient time to review a TS change within the schedular constraints of the refueling outage. Therefore, WPSC did not submit an amendment request to the NRC.

In August of 1994, in preparation for the fall 1994 refueling outage, Wisconsin Electric Power Company (WEPCO) submitted an amendment request to the NRC staff to revise the HEJ repair criteria for Point Beach Unit-2. This amendment request was similar to that discussed with the NRC staff in April of 1994 supplemented with additional analytical evaluation and prototypic testing. The technical basis for the WEPCO amendment request is documented in WCAP-14157 "Technical Evaluation of Hybrid Expansion Joint (HEJ) Sleeved Tubes With Indication Within the Upper Joint Zone," and the addendum to WCAP-14157 "Supplemental Leak and Tensile Test Results for Degraded HEJ Sleeved Tubes in Model 44/51 S/G's." The licensee amendment request was denied based on the conclusions contained in the safety evaluation report to WEPCO dated January 11, 1995.

In August of 1995, in preparation for the fall 1995 refueling outage, American Electric Power Company (AEP) submitted an amendment request to revise the location of the pressure boundary for DC Cook Unit-1. The proposed pressure boundary is based on the above referenced analytical evaluations, the results of prototypic testing, and the results of the destructive examinations and tests of the HEJ specimens removed from KNPP. The culmination of these test results shows that tubes with PTIs located 1.1 inches or further below the bottom of the HRUT have sufficient structural and leakage integrity and will not compromise the safety of the SG tube bundle. The technical basis for the AEP amendment request is documented in WCAP-14446, "Repair Boundary for Parent Tube Indications Within the Upper Joint Zone of Hybrid Expansion Joint (HEJ) Sleeved Tubes," dated August 1995. We understand that the AEP amendment request is currently being reviewed by the NRC staff; however, the review will not be completed in a time frame to allow application of the revised pressure boundary location this fall.

The purpose of this proposed amendment request is to redefine the pressure boundary for the upper sleeve-to-tube joint in HEJ sleeved tubes at the KNPP. The proposed TS change and technical basis are the same as that proposed by AEP. The proposed pressure boundary is shown on Figure 1. The proposed pressure boundary will allow PTIs located 1.1 inches below the HRUT and lower, with an added uncertainty factor to account for NDE measurement and variations in the physical dimension of the hardroll joint, to remain in service. This uncertainty factor will be established based on the NDE technique selected to perform the HEJ inspection.

Due to the extensive tube plugging performed during the 1995 refueling outage, the KNPP is currently operating in a reduced power condition of 96.3% of full power. This condition of reduced power operation and the prospect of future power derates has a significant economic impact on the owners of KNPP; therefore, we respectfully request the NRC staff to give this amendment request a high review priority. The results of the staff review will factor significantly into our 1996 outage plans.

Provided below is a description of the proposed TS change, a safety evaluation, a 10 CFR 50.92 significant hazards determination and an environmental considerations statement. Attachment 2 contains the affected TS pages.

DESCRIPTION OF PROPOSED CHANGE

This proposed amendment request will modify KNPP TS Section 4.2 and Figure TS 4.2-1 to redefine the pressure boundary for the upper HEJ sleeve joint. The proposed repair boundary is based on analytical evaluations, the results of prototypic testing, and the results of destructive examinations and tests of HEJ specimens removed from the KNPP SGs. The culmination of these test results show that tubes with PTIs located 1.1 inches below the bottom of the HRUT and lower have sufficient structural and leakage integrity, and do not compromise the safety of the SG tube bundle. The proposed changes are as follows:

1) TS 4.2.b.4.b will be expanded to define the pressure boundary and repair requirements for the upper HEJ. Specifically, the following requirements will be added:

   - HEJ sleeved tubes with circumferential indications located from 1.1 inches to 1.3 inches (not including measurement uncertainty) below the bottom of the hardroll upper transition may remain in service provided the faulted loop steam line break (SLB) projected leakage limit from all sources is not exceeded. A SLB leakage limit of 0.033 gpm shall be assumed for each indication regardless of actual length or depth.

   - HEJ sleeved tubes with circumferential and/or axial indications whose upper most extent is located greater than 1.3 inches below the bottom of the hardroll upper transition may remain in service.

   - HEJ sleeved tubes with axial indications whose upper most extent is located less than or equal to 1.3 inches below the bottom of the hardroll upper transition shall be plugged.

2) Figure TS 4.2-1 will be revised to indicate the upper HEJ pressure boundary and repair limits.

3) The basis for TS Section 4.2 will be modified to discuss the revised pressure boundary and the number of tubes that can be left in service based on the application of the SLB leak limit for the faulted loop. This leak rate value also includes primary-to-secondary leakage contribution from tubes left in service due to application of the voltage-based plugging criteria for tube support plate intersections.

SAFETY EVALUATION

The evaluation of parent tube wall degradation in HEJ sleeved tubes supports the conclusions that tube structural integrity consistent with RG 1.121 is provided along with maintenance of offsite doses within a small fraction of the 10 CFR 100 guidelines in the event of a postulated SLB event. To support this proposed TS amendment request provided below is a brief summary of:

- the HEJ sleeve design and terminology,
- the test results of the three HEJ specimens removed from KNPP,
- a discussion of the sleeve/tube joint structural issues,
- a discussion of the sleeve/tube joint leakage issues, and
- a defense of in-depth assessment

The technical details are provided in WCAP- 14157, "Technical Evaluation of Hybrid Expansion Joint (HEJ) Sleeved Tubes With Indications Within the Upper Joint Zone", WCAP-14157 addendum, "Supplemental Leak and Tensile Test Results for Degraded HEJ Sleeved Tubes in Model 44/51 S/G's" and WCAP-14446, "Repair Boundary for Parent Tube Indications Within the Upper Joint Zone of Hybrid Expansion (HEJ) Sleeved Tubes."

HEJ Sleeve Geometry and Terminology (refer to Figure 1)

The Westinghouse HEJ sleeves extend entirely through the tubesheet primary side face and are attached to the tube by first performing hydraulic expansions of the sleeve and tube at the ends of the sleeve. A mechanical roll expansion is then produced at the bottom end of the sleeve followed by a mechanical roll expansion within the upper hydraulically expanded region. The sleeves installed at the KNPP are 36 inches, 30 inches or 27 inches in total length depending in their location in the SG.

Starting from the upper end of the in-place, expanded sleeve and moving downwards towards the tube lower end, the regions of the upper sleeve-to-tube joint assembly are:

1) The non-expanded free end, approximately 1/2 inch long,
2) The upper transition from non-expanded to the hydraulically expanded region (HEUT),
3) The upper hydraulically expanded region, approximately 1 inch long,
4) The expansion transition from the hydraulically expanded region to the hardroll upper transition (HRUT), approximately 1/4 inch long,
5) The hardroll joint, approximately 1 inch long,
6) The expansion transition from the hardroll lower transition (HRLT) to the hydraulically expanded region, approximately 1/4 inch long,
7) The lower hydraulically expanded region and lower expansion transition from the expanded to the non-expanded portion of the sleeve (HELT), approximately 2 1/2 inches long.

Summary of Removed Sleeved/Tube Sample Test Results (Section 5 of WCAP-14446)

In April of 1995, three HEJ sleeved tube samples were removed from SG B. These tubes were cut and removed from the secondary side of the SG at an elevation immediately above the top of the tubesheet and below the first tube support plate. This removal method resulted in no deformation of the sleeve/tube specimens. The removed tubes were R2 C32, R2 C54 and R2 C61. Field gathered Plus Point eddy current results for R2 C32 identified a 300 to 360 degree circumferential indication in the HRLT and 360 degree circumferential indications for R2 C54 and R2 C61 in the HRLT. Evaluation of 1994 I-coil data suggests indications of approximately 270 degrees. The laboratory Plus Point evaluation was consistent with field results.

Tube R2 C54 was leak tested in the laboratory. No leakage was detected.

Tubes R2 C32 and R2 C54 were tensile tested to open the parent tube circumferential crack faces. Load versus deflection curves were generated for these two specimens. Maximum loads were achieved at the point of ligament separation in the parent tubes. The tubes and sleeves were welded at the lower end and affixed to the stationary head of the tensile machine while the tube was solely affixed to the moveable crosshead tensile machine. Testing in this condition simulated the actual configuration in the SG. Peak loads and deflections at ligament failures were 10,359 lb, 0.44 inch; and 10,700 lb, 0.53 inch; respectively for R2 C32 and R2 C54. Peak frictional loads after ligament failure were 2800 lb and 4000 lb, respectively.

The separation point of R2 C32 was in the parent tube at the top of the HRLT while the separation point for R2 C54 was approximately at the midpoint of HRLT. Tube R2 C32 had a normal (0.25 inch) HRLT while R2 C54 experienced roll down and had an elongated roll transition of about 0.5 inch. Examination of the fracture face of R2 C32 indicated the macrocrack length was 360 degrees with an average depth of 62% and maximum penetration of 92%. Limit load analysis of the non-degraded cross sectional areas of the two parent tubes estimates the overload forces to be 5980 lb and 5170 lb, for R2 C32 and R2 C54. Twenty-one ligaments were observed on the circumferential macrocrack located at the top of the HRLT indicating a highly segmented profile. All intergranular corrosion was ID initiated. Macrocrack length for R2 C54 was also 360 degrees with average and maximum crack depths of 60% and 92%. Again a segmented crack profile was detected as 19 ligaments were observed. All corrosion was ID initiated of the parent. Crack profiles for both tubes were segmented, and the crack initiation sites were scattered in elevation, i.e., the macrocrack network is not found in a single plane. No indications of corrosion or cracking were detected on the sleeves.

Sleeve/Tube Integrity (Section 6 of WCAP-14446)

Determining integrity for PTIs includes consideration of both the structural and leakage integrity.

Structural Issues

In accordance with RG 1.121, tube rupture should be precluded at a pressure loading equal to three times the normal operating primary to secondary pressure differential, or 1.43 times the SLB pressure differential, depending upon which is the most limiting. For KNPP, the most stringent RG 1.121 loading is the 3ΔP recommendation. Tube rupture is normally thought of as a double-ended guillotine break of a steam generator tube, or a failure of a tube involving localized burst with ductile tearing of the tube material at the edges of the crack. In the case of a sleeved tube with postulated circumferential degradation in the parent tube at the HEJ HRLT, tube rupture will be considered as an uncontrolled release of reactor coolant exceeding the normal makeup capacity. The tube will not experience failure or burst as a result of internal pressurization resulting in tube failure with crack tearing, but from disassociation of the separated tube end and sleeve by axial displacement of the postulated circumferentially separated parent tube.

For the configuration of an HEJ sleeved tube with a postulated 100 percent throughwall, 360° circumferential crack in the HEJ HRLT, tube rupture can only occur if the tube is displaced axially by a distance of approximately 3 to 3.25 inches. Tube displacement of this magnitude would result in complete disassociation between the separated tube end and sleeve resulting in sufficient flow area such that a release rate exceeding makeup capacity would be realized. Hybrid expansion joint sleeved tube test specimens and HEJ samples removed from KNPP were used to support the conclusion that indications which have the revised pressure boundary criteria applied will retain structural integrity such that tube slippage and axial displacement will not be expected. As a defense in depth backup to these data, analysis of the SG dimensions, fitup, and manufacturing practices has been performed to determine the lengths over which a postulated circumferentially separated tube could become displaced. This axial displacement analysis can only occur by neglecting the hardroll interaction friction force and packed TSP crevice friction forces. The postulated levels of tube slippage are calculated for plant operation during: 1) normal operation, 2) a postulated SLB, and 3) at pressure differential loadings equal to the RG 1.121 safety limits. End cap loads which could cause tube axial displacement are developed by the primary to secondary ΔP acting over the tube ID area. The maximum operating condition end cap load is 724 lbs. (ΔP = 1535 psi). During a postulated SLB, the end cap load would be approximately 1207 lbs. (ΔP = 2560 psi), and the most limiting RG 1.121 end cap load would be approximately 2172 lbs. (3ΔP = 4605 psi). Therefore, the structural integrity characteristics of the postulated degraded joint must be sufficient to resist these potential loadings in order for sleeved tube structural integrity to be maintained.

Structural Capacity Test Results

When indications were first detected in the HEJ HRLT in the parent tube, structural capability tests were performed to determine the structural characteristics of the degraded joint. Since the TSs consider sleeved tubes no different than non-sleeved tubes and considering that RG 1.121 supplies structural integrity recommendations independent of sleeved or non-sleeved tubes, the applicability of criteria can be established using current NRC documents and regulations.

A series of tests were conducted on HEJ sleeved tube specimens in which the tubes were completely machined away at various postulated crack elevations. For specimens where the tubes were completely removed by machining at the elevation corresponding to the bottom of the HRLT (approximately 1.25 inches below the bottom of the hardroll upper transition and approximately 3.0 inches below the upper end of the sleeve) structural capability of the joints was found to be greater than twice the most limiting RG 1.121 3ΔP end cap loading for KNPP (based on a 3ΔP pressure load of 4605 psi). Tube structural integrity is expected to be provided for circumferential indications 1.1 inch below the bottom of the HRLT based on the presence of a "lip" of metal formed by the transition (since the hardroll length is approximately 1.0 to 1.03 inch). This lip must be drawn over the sleeve hardroll length, and could be considered similar to the manufacturing process used for drawn over mandrol (DOM) tubing. The force required to cause this deflection of the tube would be expected to exceed the most limiting RG 1.121 recommendations. For specimens where the tubes were completely removed by machining at the elevation corresponding to the approximate midlength of the hydraulically expanded region (approximately 2.25 inches below the bottom of the hardroll upper transition and approximately 4.0 inches below the upper end of the sleeve) structural capability of the joints was found to be greater than 3.5 to 4 times the most limiting RG 1.121 3ΔP end cap load for KNPP.

A second series of tests were conducted for HEJ sleeved tubes with simulated throughwall cracks of less than 360° arc. Results of these tests are furnished in WCAP-14157, Addendum 1. Tubes were first slit 100 percent throughwall over varying arc lengths from 120° to 240° and the specimens prepared such that the slits were positioned at the top of the HEJ hardroll lower transition. Specimens were installed in a tensile testing machine and axially loaded to failure. The specimens were configured such that the tube end was attached to the movable crosshead of the machine and the sleeve end was attached to the stationary base. Test results and observations indicated that upon loading, the bending moment applied through the non-degraded ligament caused a deflection of the tube and sleeve in the direction of the slit, and produced a sufficiently large bending lockup that in most cases, even with a 240° throughwall slit, the sleeve failed in tension at approximately 8,000 lb load. For the specimens that failed in the ligament (slit location elevation 1.00 to 1.03 inch below the bottom of the hardroll upper transition), the ligament failure loads were approximately twice the tensile overload capacity of the tube considering only nondegraded ligament area loaded in tension and considerably greater than the most limiting RG 1.121 loading. In the specimens that failed in the ligament, the frictional forces developed by the interaction of the hardroll expanded areas was sufficiently large to exceed the most limiting RG 1.121 loading. These tests were performed at 600° F with no internal pressure. Therefore, it can be concluded that for a postulated sleeved tube with non-degraded ligaments in the subject area of the tube, that structural integrity characteristics would be provided in excess of the most limiting RG 1.121 loading.

For the pulled tubes, field RPC results indicate 300-360° degradation while parent tube ligament failure loads exceeded 10,000 lb. Frictional loads after ligament separation exceeded the most limiting RG 1.121 loading. For tube R2 C32, the crack location was at the top of the hardroll lower transition, and comparison of post-ligament failure frictional loads for R2 C32 would be considered conservative compared to tubes left in service as a result of the criteria.

Leakage Integrity

Elevated temperature leak tests were conducted on specimens which had the tube machined away at the bottom of the HEJ hardroll lower transition (approximately 1.25 inches below the bottom of the HEJ hardroll upper transition). Leak test results indicated essentially zero leakage under all conditions (maximum SLB leakage of 0.008 gpm, average of 0.0012 gpm). Leak tests for specimens with the tube machined away at the approximate midpoint of the HEJ HRLT (approximately 1.12 to 1.13 inch below the bottom of the hardroll upper transition) also showed a large resistance to primary to secondary leakage. Steam line break condition leakage was found to be a maximum of 0.016 gpm. These tests suggest that the presence of a "lip" of tube material below the edge of the transition provides sufficient leakage restriction.

This configuration would include a lip of approximately 0.10 to 0.07 inch below the top of the HEJ HRLT, and therefore would provide the geometric configuration such that neither significant tube axial displacement nor significant tube leakage would be expected during a postulated SLB event.

Leakage testing was also conducted on non-360° throughwall slitted tube specimens. Again, tubes were pre-slit to a throughwall condition over 240° and the slits were located at the top of the HRLT (approximately 1.0 to 1.03 inch below the bottom of the hardroll upper transition). The maximum test leakage was found to be 0.015 gpm at a ΔP of 2450 psi.

Application of Leakage Limits for Indications Left in Service as a Result of the Criteria

For indications between 1.1 inch and 1.3 inch (not including measurement uncertainty) below the bottom of the HEJ HRUT, a bounding SLB leak rate of 0.033 gpm will be applied. Conservatively, a factor of 2 is applied to the largest leakage test data point to establish a 0.033 gpm per tube leakage allowance. Application of this per tube allowance is conservative for tubes with less than 360° circumferential degradation and also conservative for tubes with non-throughwall degradation. The removed tube eddy current results indicated 360° degradation; however, none of the three samples had throughwall degradation. Application of the leakage allowance is applied for all tubes with circumferential indications between 1.1 and 1.3 inch below the bottom of the HRUT, regardless of indicated RPC angle and throughwall extent. For indications 1.3 inch or greater below the bottom of the HEJ hardroll upper transition, SLB leakage can be neglected.

Since the interim plugging criteria for TSP indications is licensed at KNPP, offsite doses in the event of a postulated SLB have been calculated consistent with the Standard Review Plan. The SLB leakage value for KNPP has been determined to be 34.0 gpm in the faulted loop. Leakage from TSP intersections has typically been less than 1 gpm, leaving up to 33.0 gpm of available leakage from other sources. At current conditions, 1000 tubes with PTIs between 1.1 and 1.3 inch below the bottom of the hardroll upper transition can remain in service as a result of application of the criteria. An unlimited number of indications greater than 1.3 inch below the bottom of the HEJ HRUT can remain in service. The number of indications between 1.1 and 1.3 inch below the bottom of the upper transition to which the repair boundary can be applied could be increased by lowering the technical specification RCS Iodine-131 concentration limit.

Defense in Depth Assessment

As a worst case evaluation, the effects of a postulated circumferentially separated tube are considered with regard to tube rupture potential. In order to evaluate this condition, the results of the dimensional study are used to establish sleeved tube structural integrity. As stated previously, the RG 1.121 recommendations are structured to prevent tube rupture during the specified conditions. The results of the dimensional analysis indicate that at a 95 percent cumulative probability, separated tube axial displacement for both normal operating and SLB conditions would be less than the 1.1 inch minimum value established by the proposed repair boundary. These values are established by averaging the maximum displacements of the tube apex and tangent points for the various plant conditions. At these displacements, remaining metal to metal contact of approximately 0.22 to 0.13 inch would be provided between the tube and sleeve in the original HEJ hardroll region. At this configuration, primary to secondary leakage would be much less than makeup capacity, and therefore, a tube rupture condition would be precluded (See attachment 4, WCAP 14446, figure 7-2, page 7-14). The establishment of the axial displacement values of the postulated circumferentially separated tube not only neglect the frictional forces developed by the HEJ hardroll, but also neglect any frictional forces developed at the tube to tube support plate intersections generated by corrosion product buildup in addition to neglecting any frictional forces developed at the tube to tube support plate intersections due to lateral displacement of the tube as the U-bend region is rotated. The 1.1 inch value used in the development of the criteria is the 95 percent cumulative probability displacement of the tube tangent point, and is the most limiting SLB displacement value.

For the postulated axial displacement as listed above, a ring of tube to sleeve contact will be provided in the original HEJ hardroll region. For tubes which have slipped such that there is no remaining metal to metal contact in the hardroll region (about 1.25 to 1.5 inch axial displacement), primary to secondary leakage was calculated to be on the order of 25 gpm. In this configuration, leakage restriction is provided by the thin gap created by the diameter difference between the tube hardroll region ID and sleeve hydraulically expanded OD. For the expected conditions at the 95 percent cumulative probability tube axial displacements, primary to secondary leakage would be expected to be far less than 25 gpm. For SLB conditions, a tube experiencing an axial displaeement at the 95 percent cumulative probability would be expected to leak at less than 2.5 gpm. Supplemental leakage testing scheduled will be performed to establish leak rates for tubes which are postulated to experience axial displacements. The intent of these tests is solely to validate the conclusions that axially displaced tubes do not represent a potential for leakage in excess of the KNPP normal makeup capacity. Results of these tests will be transmitted to the NRC.

SIGNIFICANT HAZARDS DETERMINATION

This proposed change was reviewed in accordance with the provisions of 10 CFR 50.92 to show no significant hazards exists.

1) Operation of the KNPP in accordance with the proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

Mechanical testing has shown that the inherent structural strength of the HEJ joint provides sufficient integrity such that the tube rupture capability recommendations of RG 1.121 are met, even for instances of 100 percent throughwall, 360° circumferentially oriented degradation in the HEJ HRLT region. Structural integrity recommendations consistent with RG 1.121 are supplied for all tube degradation 1.1 inch or greater below the bottom of the HEJ HRUT. Based on test data, a bounding SLB leak rate of 0.033 gpm for indications between 1.1 and 1.3 inch below the bottom of the HRUT is applied. As the leakage data base is expanded and statistical basis established, this SLB leakage allowance may be reduced. For indications existing greater than 1.3 inch below the bottom of the HRUT, SLB event leakage can be neglected.

Additional prevention from tube rupture is inherently provided by the HEJ geometry. For RCS release rates to exceed the normal makeup capacity of the plant, the tube must be postulated to experience a complete circumferential separation at the lower transition, and become axially displaeed by 3 to 3.25 inches, resulting in complete geometric disassociation between the tube and sleeve resulting in sufficient flow area to support leakage in excess of makeup capacity. During the 1989 plug top release event at North Anna Unit 1, primary to secondary release rates were calculated to be less than 80 gpm, for a flow area approximately four times larger than the flow area created by a tube which has axially displaced by about 1.25 to 1.5 inch. Analysis of the steam generator indicates that at a 95 percent cumulative probability, the tube would experience an axial displacement of less than the 1.1 inch boundary. At this level of axial displacement, a ring of metal to metal contact would remain between the tube and sleeve, and leakage would be far less than makeup. Projected leakage at this point is expected to be less than 2.5 gpm. Therefore, implementation of the proposed repair boundary will not result in tube rupture, even for a tube postulated to not behave as predicted by the available test and pulled tube data.

The proposed technical specification change to support the implementation of the HEJ sleeve tube pressure boundary for parent tube degradation in the HEJ HRLT region does not adversely impact any other previously evaluated design basis accident or the results of accident analyses for the current technical specification minimum reactor coolant system flow rate. Plugging limit criteria are established using the guidance of RG 1.121. Furthermore, per RG 1.83 recommendations, the sleeved tube assembly can be monitored through periodic inspections with present eddy current techniques.

2) The proposed license amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

Implementation of the revised pressure boundary will not introduce significant or adverse changes to the plant design basis. Mechanical testing of degraded sleeve joints supports the conclusions of the calculations that the sleeve retains structural (tube burst) capability consistent with RG 1.121. As with initial installation of sleeves, implementation of the relocated pressure boundary cannot interact with other portions of the RCS. Any hypothetical accident as a result of potential tube degradation in the HEJ HRLT region of the tube is bounded by the existing tube rupture accident analysis. Neither the sleeve design nor implementation of the tube repair boundary defined on Figure TS 4.2-1 affects any other component or location of the tube outside of the immediate area repaired.

3) The proposed license amendment does not involve a significant reduction in a margin of safety.

The safety factors used in the establishment of the HEJ sleeved tube pressure boundary are consistent with the safety factors in the ASME Boiler and Pressure Vessel Code used in steam generator design. Based on the sleeved tube geometry, it is unrealistic to consider that application of the revised pressure boundary could result in single tube leak rates exceeding the normal makeup capacity during normal operating conditions. The pressure boundary established in WCAP-14446 has been developed using the methodology of RG 1.121. The performance characteristics of postulated degraded parent tubes of HEJ tube/sleeve joints have been verified by testing to retain structural integrity and preclude significant leakage during normal and postulated accident conditions. Testing indicates that postulated circumferentially separated tubes which the repair boundary addresses would not experience axial displacement during either normal operation or SLB conditions. The existing offsite dose evaluation performed for KNPP in support of the voltage based plugging criteria for axial ODSCC at TSP intersections established a faulted loop primary to secondary leak rate of 34.0 gpm using technical specification dose equivalent Iodine-131 activity levels. Following implementation of the criteria, postulated leakage from all sources must not exceed 34.0 gpm in the faulted loop. Maintenance of this limit will ensure that offsite doses would not exceed the currently accepted limit of a small fraction of the 10 CFR 100 guidelines. The repair boundary uses a conservatively established "per indication" leak rate for estimation of SLB leakage. This leak rate is applied to all indications left in service as a result of the tube repair boundary, including non-throughwall indications and a limited number of indications of circumferential throughwall extent.

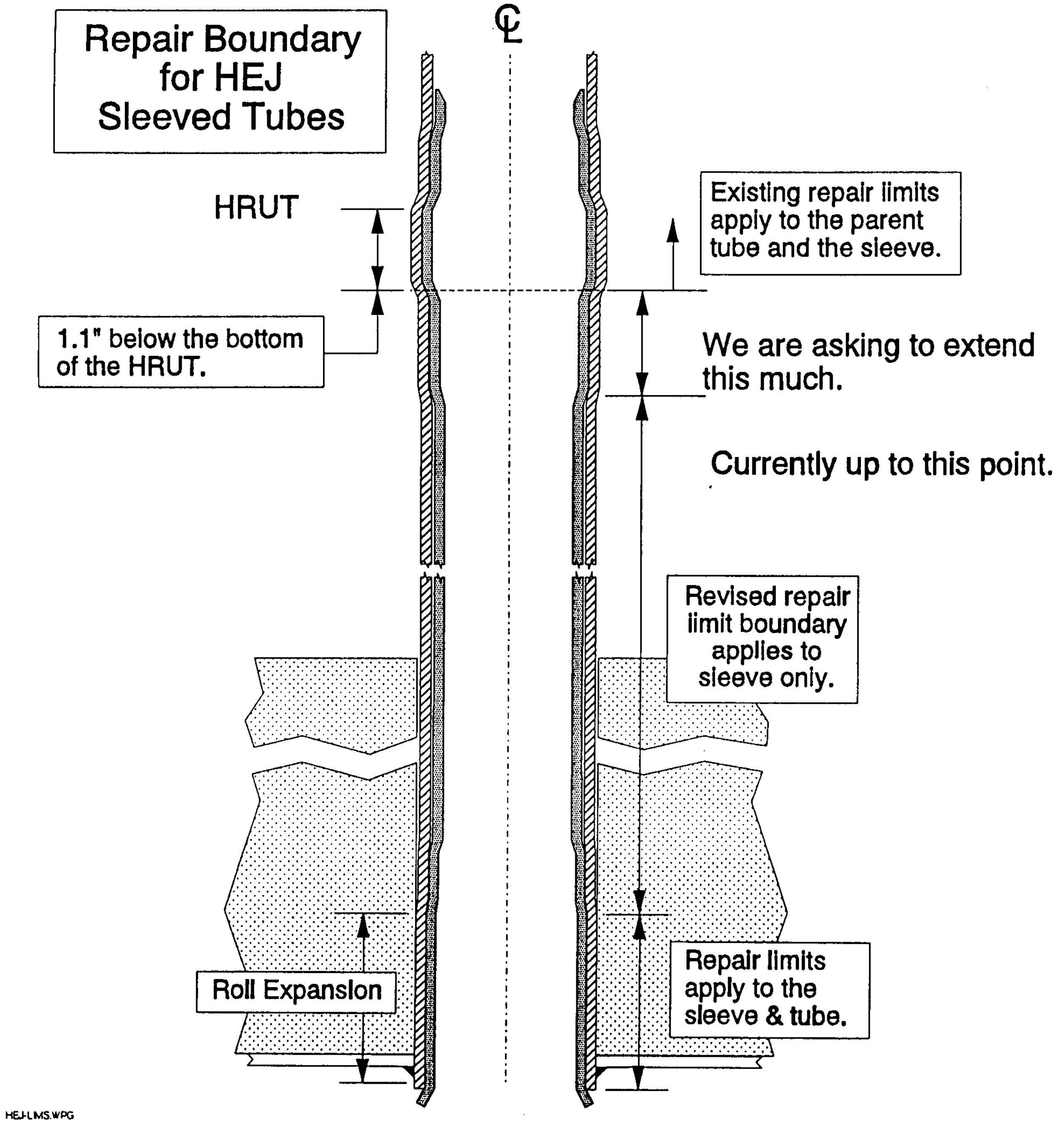
For a postulated indication whose performance is not characteristic of the test and pulled tube data, and which would experience axial displacement at the 95 percent cumulative probability value following a postulated SLB event with no operator intervention, leakage would not be expected to result in an uncontrolled release of reactor coolant in excess of normal makeup capacity.

For the three removed tube sleeve samples and nearly 1,000 PTIs detected in the field, there were no instances of degradation of elevations (multiple expansion transitions) on either side of the hardroll expansion in the same tube. This includes no instances of non-detected degradation in the upper hydraulic and hardroll upper expansion transitions for the removed tubes. One tube was identified in the most recent KNPP inspection with two separate circumferential crack elevations within the HRLT. Rapidly occurring degradation would not be expected at the upper transitions, based partly on the field inspection results. The available inspection results include two inspection programs (1994 and 1995) at Kewaunee and one at Point Beach Unit 2 (1994). Through these three inspection programs, approximately 11,000 HEJ sleeved tubes have been inspected using advanced ET techniques.

The portions of the installed sleeve assembly which represent the reactor coolant pressure boundary can be monitored for the initiation and progression of sleeve/tube wall degradation, thus satisfying the requirements of Regulatory Guide 1.83.

ENVIRONMENTAL CONSIDERATIONS

This proposed amendment involves a change to the inspection requirements with respect to the installation or use of a facility component located within the restricted area. Wisconsin Public Service Corporation has determined that the proposed amendment involves no significant hazards consideration 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. Accordingly, this proposed amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). This proposed amendment also involves changes in recordkeeping, reporting or administrative procedures or requirements. Accordingly, with respect to these items, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(10). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with this proposed amendment.



Repair Boundary for HEJ Sleeved Tubes
℄
HRUT
1.1" below the bottom of the HRUT.
Existing repair limits apply to the parent tube and the sleeve.
We are asking to extend this much.
Currently up to this point.
Revised repair limit boundary applies to sleeve only.
Roll Expansion
Repair limits apply to the sleeve & tube.
HEJ-LMS.WPG

FIGURE 1

ATTACHMENT 2

Letter from C. R. Steinhardt (WPSC)

To

Document Control Desk (NRC)

Dated

October 6, 1995

Affected TS Pages

4.2-6 through 4.2-8
B4.2-3 through B4.2-5
Figure TS 4.2-1

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