October 15, 2004

Mr. L. William Pearce
Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NO. 1 (BVPS-1) - ISSUANCE OF AMENDMENT RE: REVISED STEAM GENERATOR INSPECTION SCOPE FOR ONE CYCLE OF OPERATION (TAC NO. MC3671)

Dear Mr. Pearce:

The Commission has issued the enclosed Amendment No. 262 to Facility Operating License No. DPR-66 for BVPS-1. This amendment consists of changes to the Technical Specifications (TSs) in response to your application dated June 28, 2004, as supplemented September 3, 2004.

The amendment revises the BVPS-1 TSs surveillance requirements (SRs) 4.4.5.4.a.6, 4.4.5.4.a.8, and 4.4.5.5.d.1 and adds SRs 4.4.5.4.a.11 and 4.4.5.5.e for one cycle of operation and is applicable only to cycle 17. The proposed change revises the definition of steam generator tube inspection scope in SR 4.4.5.4.a.8 to exclude the portion of the tube within the tubesheet below the W* distance, tube-to-tubesheet weld and tube-end extension by crediting the Westinghouse W* methodology as described in Topical Report WCAP-14797, Revision 2.

A copy of the related safety evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/

Timothy G. Colburn, Senior Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-334

Enclosures: 1. Amendment No. 262 to DPR-66
2. Safety Evaluation

cc w/encls: See next page

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cc w/encls: See next page

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TBoyce	DLPM DPR	PKlein		

TSs:
Package Number: ML042730591
Accession Number: ML042730587 *SE input received. No substantive changes made.

OFFICE	PDI-1/PM	PDI-2/LA	EMCB/SC	OGC	PDI-1/SC
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PENNSYLVANIA POWER COMPANY

OHIO EDISON COMPANY

FIRSTENERGY NUCLEAR OPERATING COMPANY

DOCKET NO. 50-334

BEAVER VALLEY POWER STATION, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 262
License No. DPR-66

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by FirstEnergy Nuclear Operating Company, et al. (the licensee), dated June 28, 2004, as supplemented September 3, 2004, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-66 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendix A, as revised through Amendment No. 262, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard J. Laufer, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: October 15, 2004

ATTACHMENT TO LICENSE AMENDMENT NO. 262

FACILITY OPERATING LICENSE NO. DPR-66

DOCKET NO. 50-334

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
XVII	XVII
3/4 4-9	3/4 4-9
3/4 4-10	3/4 4-10
3/4 4-10a	3/4 4-10a
3/4 4-10b	3/4 4-10b
3/4 4-10c	3/4 4-10c
3/4 4-10d	3/4 4-10d
3/4 4-10e	3/4 4-10e
3/4 4-10f	3/4 4-10f
3/4 4-10g	3/4 4-10g
3/4 4-10h	3/4 4-10h
-----	3/4 4-10i

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 262 TO FACILITY OPERATING LICENSE NO. DPR-66

PENNSYLVANIA POWER COMPANY

OHIO EDISON COMPANY

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNIT NO. 1 (BVPS-1)

DOCKET NO. 50-334

1.0 INTRODUCTION

By application dated June 28, 2004, as supplemented by letter dated September 3, 2004, the FirstEnergy Nuclear Operating Company (FENOC, the licensee), requested changes to the Technical Specifications (TSs) for BVPS-1. The supplement dated September 3, 2004, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the Nuclear Regulatory Commission (NRC) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on August 3, 2004 (69 FR 46584).

The proposed changes would revise the BVPS-1 TSs surveillance requirements (SRs) 4.4.5.4.a.6, 4.4.5.4.a.8, and 4.4.5.5.d.1 and add SRs 4.4.5.4.a.11 and 4.4.5.5.e for one cycle of operation during cycle 17. The proposed change would revise the definition of steam generator (SG) tube inspection scope in SR 4.4.5.4.a.8 to exclude the portion of the tube within the tubesheet below the W* distance, tube-to-tubesheet weld and tube-end extension by crediting the Westinghouse W* methodology as described in Topical Report, WCAP-14797, Revision 2, "Generic W* Tube Plugging Criteria For 51 Series Steam Generator Tubesheet Region WEXTEX Expansions," dated March 2003.

Changes to pages XVII, 3/4 4-10h, and 3/4 4-10i are page numbering pagination changes which are the result of inserts to the existing TS pages made as part of the licensee's requested changes. No substantive changes to these pages were requested by the licensee. The licensee discussed pagination changes on page 2 of Enclosure 1 of the licensee's June 28, 2004, letter.

2.0 REGULATORY EVALUATION

Because of the importance of SG tube integrity, the NRC requires the performance of periodic inservice inspection (ISI) of SG tubes. These inspections detect, in part, degradation in the tubes as a result of the SG operating environment. ISIs may also provide a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken. Tubes with degradation that exceeds the tube repair limits specified in a plant's TSs are removed from service by plugging or are repaired by sleeving (if approved by the NRC for use at the plant). The plant TSs provide the acceptance criteria related to SG tube inspections.

The requirements for the inspection of SG tubes are intended to ensure that this portion of the reactor coolant system maintains its structural and leakage integrity. Structural integrity refers to maintaining adequate margins against gross failure, rupture, and collapse of the SG tubes. Leakage integrity refers to limiting primary-to-secondary leakage during normal operation, plant transients and postulated accidents to ensure that the radiological dose consequences are within acceptable limits.

In reviewing requests of this nature, the NRC staff verifies that the structural and leakage integrity of the tubes will continue to be maintained consistent with the plant design and licensing basis. This includes verifying that the applicable General Design Criteria (GDC) (e.g., GDC 14 and 32) of Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, are satisfied and that the structural margins inherent in Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR [pressurized-water reactors] SG Tubes," dated August 1976, are maintained. This also includes verifying that a conservative methodology exists for determining the amount of primary-to-secondary leakage during design-basis accidents. The amount of leakage is limited to ensure that offsite and control room dose criteria are met. The radiological dose criteria are specified, in part, in 10 CFR Part 100 and in GDC 19 of Appendix A to 10 CFR Part 50.

The NRC previously approved similar, but not identical, license amendment requests for Diablo Canyon Power Plant, Unit Nos. 1 (NUDOCS accession number 9903030010) and 2 (Agencywide Documents Access and Management System (ADAMS) accession number ML021200166) in License Amendment Nos. 129 and 127, respectively, for two cycles of operation. In addition, the NRC approved a similar request for Sequoyah Nuclear Plant, Unit 2 (ADAMS accession number ML021340595) in License Amendment No. 266 for one cycle of operation.

3.0 <u>TECHNICAL EVALUATION</u>

The proposed amendment would revise the BVPS-1 TSs for one cycle to change the scope of the SG tube inspections required in the SG tubesheet region by applying a methodology referred to as W* (W-star). Specifically, the proposed amendment would revise the BVPS-1 TS SR 4.4.5.4.a.8 to exclude from inspection the bottom portion of the tube within the tubesheet region. That is, the new specification would require only an inspection of the upper portion of the tube within the hot-leg tubesheet region. The length of the tube required to be inspected is referred to as the W* distance. Currently, the TSs require, in part, an inspection of the entire portion of the SG tube within the hot-leg tubesheet region. Essentially, the new specification would not require inspection of the portion of the tube from the tube end to the W* distance.

The proposed change will also revise SR 4.4.5.4.a.6 on SG tube repair criteria, add SR 4.4.5.2.e to require a 100% rotating-probe inspection of the tube in the tubesheet for the hot-leg W* distance, add new W* terminology definitions in 4.4.5.4.a.11, and add new reporting criteria in SR 4.4.5.5.d.1 and SR 4.4.5.5.e associated with implementation of the W* methodology. This amendment would only apply to BVPS-1 during cycle 17 of operation. FENOC's proposed change requires that any tube with service-induced degradation (within the tubesheet) in the W* distance or within the top 8 inches of the portion of the tube below the top of the tubesheet (TTS), whichever distance is greater, to be repaired.

3.1 Background

BVPS-1 is a 3-loop, Westinghouse-designed plant with Model 51 SGs. Each SG contains about 3400 tubes. The SG tubes are mill-annealed Alloy 600 with an outside diameter of 0.875 of an inch and a wall thickness of 0.050 of an inch. Each U-tube is roll-expanded for approximately 2.75 inches into the bottom of the tubesheet, then secured into the remaining portion of the tubesheet by an explosive expansion process referred to as the Westinghouse Explosive Tube Expansion (WEXTEX) process. The tubesheet is approximately 21 inches thick and each tube is expanded for essentially the full thickness of the tubesheet. Each tube is also welded to the primary side of the tubesheet near the tube end. This weld provides a leak tight boundary and also provides resistance to tube pullout. The WEXTEX process forms an interference fit between the tube and tubesheet. The transition from the expanded portion of the tube to the unexpanded portion of the tube is referred to as the WEXTEX transition or the expansion transition. Each SG contains seven tube support plates to provide lateral support to the tubes. The tube supports are carbon steel plates with drilled holes through which the tubes are inserted.

The existing plant TSs do not take into account the reinforcing effect of the tubesheet on the external surface of the expanded tube. The presence of the tubesheet constrains the tube and complements tube integrity in that region by essentially precluding tube deformation beyond the expanded outside diameter of the tube. The resistance to both tube rupture and tube collapse is significantly enhanced by the tubesheet reinforcement. In addition, the proximity of the tubesheet to the expanded tube significantly reduces the leakage from any through-wall defect.

Based on these considerations, power reactor licensees have proposed, and the NRC has approved, alternate repair criteria for defects located in the SG tube contained in the lower portion of the tubesheet, when these defects are a specific distance below the expansion transition or the TTS, whichever is lower.

The W* methodology defines a distance, referred to as the W* distance, such that any type or combination of tube degradation below this distance is considered acceptable, i.e., even if inspections below this region identified degradation, the regulatory requirements pertaining to tube structural integrity would be met provided there were no flaws within the W* distance. The W* distance is determined by calculating the amount of undegraded tubing, termed the W* length, needed to address tube pullout and leakage concerns. This W* length is measured from the bottom of the WEXTEX transition region. The key consideration in determining the W* length is the amount of undegraded tubing necessary to prevent axial pullout of the tube from the tubesheet. Tube pullout could result from the internal pressure in the tube. In addition to the W* length, nondestructive examination (NDE) uncertainties must be accounted for to determine the W* distance. These uncertainties include, but are not limited to, the uncertainties in determining the location of the bottom of the WEXTEX expansion and the total inspection distance below this point, i.e., W* length. These uncertainties are addressed in the W* methodology and were discussed in the NRC staff's safety evaluation approving the W* repair criteria for Diablo Canyon Power Plant, Unit Nos. 1 and 2.

The generic W* analysis presented in WCAP-14797, Revision 2, uses bounding or nonplant-specific values for secondary system pressure and primary temperature to determine the required W* length for two regions of the tube bundle. This analysis considered the forces acting to pull the tube out of the tubesheet, i.e., from the internal pressure on the tube and the forces acting to keep the tube in place. These latter forces are a result of friction and the forces arising from (1) the residual preload from the WEXTEX expansion process, (2) the differential thermal expansion between the tube and the tubesheet, and (3) internal pressure in the tube within the tubesheet. In addition, the effects of tubesheet bow due to pressure and thermal differentials across the tubesheet were considered since this bow causes dilation of the tubesheet holes from the secondary face to approximately the midpoint of the tubesheet and reduces the ability of the tube to resist tube pullout. The amount of tubesheet bow varies across the tube bundle with tubes in the periphery (referred to as Zone A tubes) experiencing less bow than tubes in the interior of the SG tube bundle (referred to as Zone B tubes). In fact, the analysis provided indicates that the W* length for Zone A tubes is 5.2 inches and the W* length for Zone B tubes is 7.0 inches. In addition to the W* length, the analysis in WCAP-14797 also considered the uncertainties associated with NDE.

3.2 BVPS-1 Proposal

The licensee's basis for using rotating-probe eddy current to inspect from the TTS to the W* distance is documented in it's license amendment request and in WCAP-14797, Revision 2. Operating conditions assumed in the generic WCAP analysis bound the operating conditions at BVPS-1 such that the W* distance calculated using plant-specific conditions would be less than the W* distance identified in WCAP-14797. For example, the generic analysis assumes a hot leg temperature of 590 ^{o}F whereas the limiting hot leg operating temperature at BVPS-1 is approximately 611 ^{o}F. Therefore, the generic analysis provides less thermal tightening of the WEXTEX joint than would actually be present in the BVPS-1 SGs. The secondary system pressure assumed for the generic analysis also provides for less pressure tightening of the WEXTEX joint compared to the BVPS-1 plant conditions.

The BVPS-1 proposal is also more conservative than that discussed in WCAP-14797 for other reasons. For example, the BVPS-1 W* proposal requires all service-induced degradation in the W* distance or 8 inches below the TTS, whichever distance is greater, to be repaired. In other words, BVPS-1 will not permit axial cracks to remain in the W* distance, i.e., BVPS-1 will not apply the flexible W* length discussed in WCAP-14797. The BVPS-1 W* proposal also uses a bounding leakage methodology based on tube-to-tubesheet contact pressures that differs from the DENTFLO Code leakage model presented in WCAP-14797. BVPS-1 will also conservatively apply the greater W* length calculated for Zone B tubes to all tubes in the SG.

The following sections summarize the NRC staff's evaluation of the proposed BVPS-1 W* proposal in terms of maintaining SG structural and leakage integrity.

3.3 Tube Structural Integrity

The BVPS-1 proposal will permit tubes with defects to remain in service; therefore, the licensee must demonstrate that the tubes returned to service using the W* methodology will maintain adequate structural integrity. Tube rupture and the pullout of a tube from the tubesheet are two potential modes of structural failure considered for tubes returned to service under the W* methodology.

In order for tube rupture to occur, any known flaws remaining in service using the W* criteria would need to propagate above the tubesheet's secondary face. If the entire flaw remains within the tubesheet, the reinforcement provided by the tubesheet will prevent tube rupture. The W* methodology proposed by BVPS-1 requires a rotating-probe exam in the W* distance and the repair of any service-related degradation in the W* distance or 8 inches below the TTS, whichever distance is greater. Therefore, any known flaws remaining in service following the rotating-probe examinations will be located a minimum of 8 inches below the TTS. Industry operating experience shows flaw growth rates within the tubesheet are well below that necessary to propagate a flaw from 8 inches below the TTS to outside the tubesheet. Therefore, it's not likely that any of these flaws will grow in an axial direction and extend outside the tubesheet. Thus, tube burst is precluded for these flaws due to the reinforcement provided by the surrounding tubesheet.

In the event that flaws are located within the W* distance and are not detected with the rotating-probe inspection or if new flaws initiate in the W* distance in the operating cycle following the inspection, there is a potential that these flaws could grow in the axial direction and extend outside the tubesheet. As a result, the NRC staff considered the conditions that would be necessary to structurally fail a tube with this type of flaw. SG tube rupture is primarily a function of flaw geometry, e.g., length, the differential pressure across the tube wall, and the flaw location. In order to remove adequate margins for tube burst under all operating conditions, axial, through-wall tube flaws must exceed a certain length, typically on the order of one-half inch or longer, and have no external restraint, i.e., occur in the free span. Partially through-wall flaws would require additional length in order to become susceptible to spontaneous rupture based on empirical models for tube burst. Thus, these flaws would have to extend a significant distance above the tubesheet to degrade the margins of structural integrity for the affected tube, i.e., tubes with undetected flaws slightly below the TTS. In addition, restriction of a flaw on one end by the tubesheet would further elevate the burst pressure of this tube. Flaw growth rates necessary to reach a critical flaw size are unlikely to occur. Therefore, flaws remaining in service under either of the two scenarios described above should maintain adequate margins for tube burst.

The other postulated structural failure mode for tubes remaining in service according to the W* methodology is pullout of the tube from the tubesheet due to axial loading on the tube. Differential pressures from the primary side to the secondary side of the SG impart axial loads into each tube that are reacted at the tube-to-tubesheet interface. Axial tube loading during normal operating conditions can be significant. The peak postulated loading, however, occurs during events involving a depressurization of the secondary side of the SG, e.g., main steamline break (MSLB). The presence of circumferentially oriented degradation within a SG tube under axial loading decreases the load-bearing capability of the affected tube. If a tube becomes sufficiently degraded, these loads could lead to an axial separation of the tube.

Resistance to tube pullout is provided by the interference fit created during the tube explosive expansion, i.e., WEXTEX process. In addition, increasing the temperature of the system and the internal pressure of the tube creates a tighter interference fit between the tube and the tubesheet to further resist tube pullout. The analysis supporting the licensee's proposed modifications to the plant TSs addressed the limiting conditions necessary to maintain adequate structural integrity of the tube-to-tubesheet joint. Specifically, the tube must not experience excessive displacement relative to the tubesheet under bounding loading conditions with appropriate factors of safety considered. The licensee's amendment proposal indicated all cracks within the W* distance (including those with circumferential orientation) will be repaired. To justify the acceptability of any type or combination of tube degradation below the W* distance, the licensee completed an assessment using analytical calculations and laboratory experiments. This assessment included pullout tests of prototypical SG tube-to-tubesheet joints to evaluate the length-of-sound tubing necessary to maintain the appropriate structural margins for tubes that may contain degradation within the tubesheet. The test specimens were subjected to internal pressurization and axial loadings at various temperature conditions in order to demonstrate acceptable structural capabilities under a range of loading conditions. Despite using configurations with lower structural capabilities than expected of actual in-service SG tubes, the test program demonstrated that tubes remaining in service according to the W* methodology resisted pullout from the tubesheet with margins meeting or exceeding those inherent in RG 1.121.

In summary, the W* repair criteria was established, in part, to limit the potential for the growth of cracks into the freespan region above the tubesheet and to maintain adequate strength to resist tube pullout from the tubesheet. The confinement of the surrounding tubesheet for all flaws left in service using this proposed alternate repair criteria will prevent tube structural failure by tube burst. Repair of all service-induced degradation within the W* distance will ensure that tube pullout from the tubesheet under the limiting conditions is precluded. On these bases, the NRC staff has concluded that tubes returned to service using the W* repair criteria will maintain adequate structural integrity.

3.4 Tube Leakage Integrity

In assessing leakage integrity of a SG under postulated accident conditions, the leakage from all sources, i.e., all types of flaws at all locations must be assessed. The combined leakage from all sources is limited to below a plant-specific limit determined based on radiological dose consequences. The BVPS-1 plant-specific limit is 14.5 gallons per minute (gpm). Since the W* methodology does not require inspections below the W* distance, there is a potential that flaws which could leak will exist below the W* distance. As a result, the licensee has developed a methodology, as part of the W* methodology, for determining the amount of accident-induced primary-to-secondary leakage from flaws in this region of the tubesheet. This methodology and the NRC staff’s review of this methodology is discussed below.

A combination of laboratory leak test data and analytical models were used to determine the amount of leakage from flaws left in service using the W* criteria. In general, this information indicated the following relationships important to tube leakage assessment: leak rates decrease with increasing contact pressure; leak rates decrease with increasing crevice length; contact pressure increases with depth below the TTS.

The licensee’s W* amendment proposal states that all service-induced degradation from the TTS to the W* distance or 8 inches, whichever distance is greater, will be repaired. Since the W* criteria permits all forms of degradation below the W* distance to remain in service, the licensee evaluated leakage from postulated indications below the W* distance. The proposed approach calculates total leakage from degradation below the W* distance by evaluating indications in two tube segments: (1) between 8 inches and 12 inches below the TTS, and (2) more than 12 inches below the TTS. This methodology requires a determination of the total number of indications within these two tube increments and the leak rate from these indications.

The licensee's leakage methodology approach relies on several relationships developed from data in WCAP-14797. Leak tests were performed on representative WEXTEX test samples with holes drilled at various locations in order to produce 1.25-inch, 2-inch and 3-inch nominal crevice depths. An average contact pressure was determined for each of the drilled-hole specimen leak rate samples. These average contact pressures were then related to SG contact pressures calculated as a function of distance below the TTS, for the most limiting tube under the most limiting operating condition. That is, contact pressures were calculated assuming the limiting MSLB conditions, when tubesheet bow and accompanying tubesheet hole dilation effects are maximum. The licensee calculated leakage for tube indications between 8 and 12 inches below the TTS by applying an upper 90% prediction leak rate obtained from the 1.25-inch nominal crevice test samples. The licensee applied the 1.25-inch crevice test leak rates to indications between 8 and 12 inches below the TTS since the contact pressure at 8 inches below the TTS was greater than the average contact pressure in the 1.25-inch crevice test samples. In a similar manner, the licensee calculated leakage from indications located more than 12 inches below the TTS using the upper 90% prediction leak rate from the nominal 3-inch crevice depth leak rate samples.

In addition to determining the tube leak rate from an indication at a depth of 8 inches and 12 inches below the TTS, the licensee also projected the total number of indications below the W* distance in order to calculate the leakage from all indications. The total number of indications remaining in service during the next operating cycle at a depth of 8 to 12 inches below TTS was projected by evaluation of historic eddy-current inspection results. In addition, the licensee committed to consider the refueling outage 16 (1R16) inspection results and increase the number of projected indications, if warranted. Although these indications would be expected to be spread over all three SGs, the licensee conservatively assumed all postulated indications within this range were located in one SG. BVPS-1 also conservatively assumed all postulated indications between 8 and 12 inches below TTS were circumferential and 100% through-wall over 360 ^{o}. Using a similar approach, the licensee calculated the total number from indications located greater than 12 inches below the TTS. In this case, the licensee assumed all tubes remaining in service contain a 360 ^{o} circumferential, 100% through-wall flaw, i.e., a tube sever, located 12 inches below TTS. Given past plant-specific and industry operating experience, the NRC staff considers the assumption that all tubes contain circumferential through-wall flaws at 12 inches below TTS, along with application of an upper 90% leak rate to these flaws, to be conservative given the current condition of the SGs.

After determining the leak rates and the number of indications located (1) between 8 and 12 inches below the TTS, and (2) more than 12 inches below the TTS, the total leakage from indications in the tubesheet was obtained by multiplying the total number of indications at these elevations by the appropriate leak rates.

As discussed above, the NRC staff reviewed the licensee's leakage methodology that relates an average contact pressure from laboratory leak test samples to contact pressures at certain tubesheet depths within the SG. This average contact pressure was calculated for each test sample by dividing the calculated total contact pressure by the effective contact length, after accounting for end effects and tube staking. In order to assess the relative conservatism of the licensee's leakage methodology, the NRC staff compared the contact pressures at 8 inches and 12 inches below the TTS for the limiting design-basis accident conditions to the contact pressures for the 1.25-inch and 3-inch nominal crevice depth leak test samples. For those indications greater than 12 inches below the TTS, the NRC staff considers use of the leak rates from the 3-inch crevice samples to be acceptable, given the maximum contact pressure of the sample, the actual crevice length of the sample, and the assumption concerning the number and severity of flaws. The NRC staff has some concern, however, when comparing the average contact pressure for the 1.25-inch crevice depth leak test samples to contact pressures for indications located approximately 8 inches below the TTS. According to the data presented in WCAP-14797, the contact pressure at approximately 8 inches below the TTS is less than 100 psi greater than the averaged contact pressure from the test samples. If the maximum contact pressure, rather than the average contact pressure, is the dominant factor that determines leak rate, the NRC staff can not verify that 1.25-inch crevice depth sample leak rates based on average contact pressures are conservative for indications located 8 inches below the TTS in the SG. Given other conservative assumptions, e.g., all indications in this range are through-wall and in one SG, and considering that the leak rate data is applied to postulated indications from 8 inches up to 12 inches below the TTS, the NRC staff considers this leakage methodology acceptable for one cycle of operation.

To further evaluate the bounding leakage methodology approach presented by the licensee, the NRC staff also considered alternate ways of relating the leak test results to contact pressures within the SG tubesheet. From the data in WCAP-14797, the NRC staff plotted the WEXTEX drilled-hole leak rates as a function of test sample average contact pressure. Using the calculated tube contact pressures at various depths during MSLB conditions, the NRC staff determined the corresponding leak rate using this plot. The leak rates presented by the licensee using the licensee's leakage method were either more conservative or similar to those obtained by the NRC staff using a direct relationship between test leak rates and test sample contact pressures.

The licensee's application of the W* criteria and accompanying bounding leakage methodology resulted in postulated limiting condition leak rates, that when combined with all other sources of leakage, will remain below the plant-specific allowable limits. On this basis, the NRC staff has concluded that the licensee has an acceptable methodology for assessing leakage below the W* distance, thereby ensuring adequate leakage integrity.

3.5 Reporting Requirements

Within 90 days of returning the SGs to service (Mode 4), the licensee will report: the total number of indications identified from the W* inspections during 1R16, their location relative to the bottom of the WEXTEX transition and TTS, the indication orientation, and an assessment of the number and severity of the indications.

3.6 Summary

The NRC staff's approval for BVPS-1's upcoming operating cycle, i.e., Cycle 17, results from the licensee demonstrating that applicable structural integrity and leakage integrity requirements will be met. This approval is based, in part, on inspections and conservative assumptions involving the licensee's implementation of the W* repair criteria including:

1. The licensee is performing rotating-probe eddy-current inspections and repairing all service-induced degradation to a minimum depth of 8 inches below the TTS. The rotating probe is capable of detecting flaws with axial and circumferential orientations.

2. The generic W* distance for the most limiting Zone B tubes (interior of tube bundle) will be applied to the entire SG, which is conservative for the Zone A tubes (peripheral tubes). The W* distance for Zone B tubes represents the most limiting W* tube length in the most limiting region of the SG and, therefore, bounds all other tubes in the SG.

3. The generic W* distances were determined using bounding parameters, i.e., secondary-side pressure and primary-side temperature, resulting in more conservative W* distances than would be obtained using plant-specific operating parameters. The generic W* distances were also determined from lower bound tube pull forces for WEXTEX expansions (based on a smooth tubesheet hole) in order to maximize the W* distance and bound the variability in WEXTEX expansions.

4. The most limiting region of the tube bundle is Zone B, which is in the interior of the tube bundle. If tubes in this region began to pull out of the tubesheet, they would be constrained by contact with neighboring tubes. As a result, the likelihood that a tube would pull out of the tubesheet is small. This effect was not considered in the development of the W* distance and adds conservatism to the evaluation.

5. BVPS-1 tubes are experiencing denting at the tube support plates which would further restrain tube pullout and would likely prevent the axial pressure load necessary to cause tube pullout. This effect was not considered in the development of the W* distance and adds conservatism to the evaluation.

6. The licensee projects all postulated indications between 8 inches and 12 inches below the TTS are circumferential, 100% through-wall over 360 ^{o}, and occur in one SG.

7. The licensee assumes all tubes remaining in service contain a 360 ^{o} circumferential, 100% through-wall flaw, i.e., a tube sever, located 12 inches below TTS. This assumption is conservative given industry rotating-probe inspection results within the tubesheet region.

8. Flaws postulated below the W* distance are assumed to be leaking although industry operating experience has demonstrated negligible leakage under normal operating conditions, even when cracks are located in a tube-to-tubesheet expansion transition zone.

9. An 800 psi secondary-side pressure in the crevice was assumed when calculating SG tube contact pressures in WCAP-14797, but no secondary-side crevice pressure was assumed when calculating contact pressures for the WEXTEX leak rate test samples.

Therefore, the NRC staff considers the licensee's proposal, which limits the extent of tube inspections within the hot-leg tubesheet to include the distance from the TTS to the W* distance or 8 inches, whichever is lower, to be an acceptable approach for one cycle of operation.

The NRC staff concludes the licensee's proposed methodology for assessing structural and leakage integrity for flaws in the tubesheet region is acceptable. Therefore, the NRC staff concludes that the licensee's proposal to limit the tube inspection scope in the hot-leg tubesheet is an acceptable approach for one cycle of operation.

4.0 STATE CONSULTATION

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

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The NRC staff has determined that the amendment involves no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (69 FR 46584). Accordingly, the amendment meets 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 the amendment.

6.0 CONCLUSION

The Commission 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 amendment will not be inimical to the common defense and security or to the health and safety of the public.

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