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August 1, 1988

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

Attention: Mr. J. J. Hayes, Jr.

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
Technical Specification Change
Steam Generator L* Criteria

Gentlemen:

South Carolina Electric & Gas Company (SCE&G) hereby requests a revision to section 3/4 4.5, "Steam Generators," of the Virgil C. Summer Nuclear Station (VCSNS) Technical Specifications. The purpose of this request is to allow for an alternative to tube plugging or sleeving in the steam generators for indications which occur in the tubesheet area. This alternate method, designated the L* criteria, defines a length of undegraded expanded tube in the tubesheet which is sufficient to maintain, well below the Technical Specification limit, any potential leakage resulting from cracks occurring further down into the tubesheet. Use of the L* criteria requires the condition of the degradation in the tubesheet be assessed to determine the orientation and location of the cracks. This methodology is expected to provide SCE&G with considerable relief from plugging or sleeving unnecessarily, thereby enhancing the future overall thermal performance of the plant.

The amendment is being proposed due to the history of eddy current indications of tube degradation in the mechanical roll expanded portion of the tubes within the tubesheet in the steam generators at VCSNS. It has been determined through interpretation of eddy current examinations that the tube degradation occurring in the VCSNS steam generators is of the type associated with primary water stress corrosion cracking (PWSCC). Using existing Technical Specification tube plugging criteria, many of the tubes with these indications would have to be repaired or removed from service. With new analyses, it can be shown that tube plugging or repair is not required in many cases to maintain tube bundle integrity. The proposed amendment takes advantage of these new analyses and offers many benefits including 1) precluding occupational radiation exposure that would otherwise be incurred by plant workers involved in tube plugging or repair operations, 2) minimizing the loss of margin in the reactor coolant flow through the steam generator in LOCA analyses, and 3) avoiding loss of margin in reactor coolant system flow and therefore assisting in assuring that minimum flow rates are maintained in excess of that required for operation at full power. Reduction in the amount of tube plugging or repair required can also reduce the length of plant outages and reduce the time that the steam generators are open to the containment environment during an outage.

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Change: LPOR ; INP
NRC POR ; INP

The Model D-3 steam generators at VCSNS were fabricated with a full depth roll expansion in the lower end of the tube above the tube to tubesheet weld. The presence of the tubesheet acts to constrain the tube and complement its integrity in that region by essentially precluding tube deformation beyond its expanded outside diameter. In addition, the proximity of the tubesheet significantly affects the leak behavior of through wall tube cracks in this region. The elastic preload and interference fit between tube and the tubesheet due to the roll expansion provides an effective barrier to significant leakage from cracks and other tube degradation in the expanded tube.

Tube plugging criteria have been developed for indications of tube degradation in the tube expansion region below the transition of the mechanically expanded/unexpanded portions of the tube. Previously, a criteria, designated the F^* criteria, has been approved for use in the VCSNS steam generators. The F^* criterion represents a length, designated F^* , of continuous roll expansion in the tubesheet such that tube pullout would not occur during either normal operation or postulated accident condition loadings. The F^* distance for VCSNS has been set at 1.6 inches and is measured from the bottom of the transition between the roll expansion and the unexpanded tube. The implicit assumption of a circumferential severance of a tube in the development of the F^* criterion permitted the conclusion that degradation of any extent or orientation within the tubesheet below the F^* distance is acceptable during normal and postulated accident conditions. This assumption results in a distance that is longer than necessary to provide a limit to significant leakage in excess of the Technical Specification allowances. Existing VCSNS steam generator tube plugging and repair criteria do not take into account the reinforcing effect of the tubesheet on the external surface of the tube in the portion of the tube expansion above the F^* location.

To address some of the eddy current indications ending at an elevation too high in the tube to be in the F^* category an additional alternate plugging criteria, designated the L^* criteria, was developed. The L^* criteria defines a length, L^* , of undegraded expanded tube which is sufficient to maintain, well below the Technical Specification limit, any potential leakage. Use of the L^* criteria requires that the condition of the degradation below the L^* distance be assessed. For those tubes in which the degradation below L^* is determined to be axial or near axial (not greater than 30°) cracking, the degraded tube provides sufficient structural strength to preclude pullout of the tube and it may remain in service without repair or plugging.

The required engagement length, L^* , of roll expansion to preclude significant leakage under normal operation and postulated accident loading conditions was determined to be 0.50 inches. (This value does not include an allowance for eddy current elevation measurement uncertainty.) This L^* distance is measured from the bottom of the transition between the expanded and unexpanded portions of the tube. In the case of a transition located above the top of the tubesheet, the L^* distance is measured from the top of the tube sheet.

In order to evaluate the L^* criterion concept for indications within the top portion of the tubesheet, an evaluation of the strength of degraded tubes was made. Based on plant operation and laboratory experience the configuration of any cracks, should they occur, is axial. For axial or nearly axial indications in the tubesheet region, the tube end remains structurally intact minimizing any potential for tube pullout. The strength of tubes with axial or near axial cracks has been evaluated using analysis and testing. In order to implement the L^* criteria, a minimum of 3.0 inches of the tube, beginning at the top of the tubesheet and extending down into the tubesheet, must be inspected using a rotating pancake coil (RPC) eddy current technique (or equivalent) to determine the condition of the tube. A minimum of 1.3 inches of sound expanded tube, separated by no more than 2 areas of tube degradation (cracks less than 1/2 inch and not greater than 30° from axial), must be found in the inspected portion of tube to ensure tube strength and prevent tube pullout.

The L^* engagement length determination was derived from preload, tube pullout, hydraulic proof (pressure), and leak testing done to develop the F^* criteria. An evaluation consisting of analysis and testing programs was conducted to verify that the strength of tubes with axial or near axial cracks in the roll expansion region is greater than that required to resist pullout forces during normal operation and postulated accident loading conditions. An additional program of tests was done to verify that a roll expansion with the length of L^* is sufficient to significantly restrict leakage during normal operating and postulated accident condition loadings. The leak testing done to validate the L^* distance used holes drilled through the tube to simulate the ends of axial cracks. The F^* leak testing had used a less sophisticated method for simulating tube degradation using a circumferential cut through the tube. The acceptance criteria for the leak testing was based on maintaining the total leakage through the L^* distance to less than the primary to secondary leakage limit in the Technical Specifications. To provide operational flexibility, the acceptance criteria was determined using only a fraction of the Technical Specification limit (.117 gpm). This value was divided by a number of tubes larger than the number of tubes expected to use the L^* criteria (L^* can be applied for up to 2648 tube ends per steam generator) to get a final acceptance criteria for average test specimen leakage. The results of the L^* leak testing compared favorably with the acceptance criteria. For normal operating pressure differential, primary to secondary leakage for an L^* value of 0.5 inch was negligible. The leak testing included tests of lengths shorter than 0.5 inch to demonstrate that the function of leak rate versus length of sound expansion is not near a threshold value in the region of the L^* length chosen.

The total L^* distance value to be contained in the Technical Specifications includes 0.06 inch as an allowance for eddy current evaluation measurement uncertainties. SCE&G will be utilizing a RPC probe to perform the inspections associated with implementing the L^* criteria. The applicable uncertainties associated with this method include those which result from identifying the bottom of the roll transition (BRT) and the top or bottom tip

of the crack. As a result of experimental work done by Westinghouse, uncertainty associated with the location of the BRT using the RPC was found to be ± 0.030 . During lab testing the uncertainty by visually locating the BRT was determined to be ± 0.040 inch. The uncertainty associated in identifying the crack tip (either top or bottom) was best estimated to be $\pm \frac{1}{2}$ of the coil diameter, or 0.030 inch. Using the square root sum of the squares method, the overall uncertainty was therefore calculated to be ± 0.06 inch.

Degradation of the type for which the L^* criteria has been developed, axial cracking, has been shown to be self limiting and not to rapidly grow into a length which could lead to an increased probability of a tube rupture. The use of the L^* criteria could not affect the probability of occurrence of any other accident which originates from conditions outside the steam generator. The limiting of the total leakage from L^* tubes to less than the Technical Specification limit will assure that the consequences of any analyzed accident are not increased by the use of the L^* criteria. The use of this criteria could not cause the steam generator or any other equipment important to safety to malfunction. Existing tube rupture analyses bound the effects of any hypothetical failure of the tube due to the use of the L^* criteria and use of the L^* criteria could not result in the possibility of an accident different from those previously analyzed. The margin of safety is provided by the safety factors implicit in the use of the ASME Code to analyze the structural integrity of the tubes, the safety factors included in the recommendations of Regulatory Guide 1.121, and the margin represented by the difference in the size of a crack sufficient to exceed Technical Specification leak limits and the minimum size of crack required to result in tube rupture or exceed analysis assumptions in the steamline break analysis.

On the basis of the evaluation above and as further detailed in the attached WCAP 11857, it is determined that tubes with tube degradation which can be categorized as axial or near axial cracking (not greater than 30°) within the tubesheet region below the L^* distance (0.56 inches, including eddy current uncertainty) can be left in service. Tubes with tube degradation which is located a distance of less than L^* below the bottom of the transition between the expanded and unexpanded tubes or the top of the tubesheet, whichever is lower, should be removed from service by plugging or repairing in accordance with Technical Specification requirements.

Attachment I to this letter contains the requested marked-up Technical Specification pages.

Attachment II provides the no significant hazards consideration evaluation to support this Technical Specification change. The use of the L^* criteria will not increase the probability or consequences of a previously analyzed accident, or increase the probability or consequences of malfunctions of equipment important to safety. The margin of safety which, in part, is provided by leakage limits in the Station Technical Specifications, the safety factors included in the ASME Code, and safety factors included in Regulatory Guide 1.121 is not reduced.

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Also provided are 10 copies each of Westinghouse WCAP-11857 (Proprietary) and WCAP-11858 (Non-Proprietary), "Tubesheet Region Tube Alternate Plugging (L*) Criteria for Steam Generators in the V. C. Summer Nuclear Station" and Westinghouse letter "Application for Withholding Proprietary Information from Public Disclosure" (CAW-88-074) with affidavit CAW-81-79.

As WCAP-11857 contains information proprietary to Westinghouse Electric Corporation, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b) (4) of Section 2.790 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations. Correspondence with respect to the proprietary aspects of the Application for Withholding or the supporting Westinghouse affidavit should reference CAW 88-074 and should be addressed to R. A. Wiesemann, Manager Regulatory and Legislative Affairs, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, Pennsylvania 15230.

Please note that SCE&G has requested in a letter to the NRC dated May 16, 1988, that item 10 on page 3/4 4-14a be revised; however, to avoid confusion and keep the issues separate, the present submittal does not reflect the change being requested in the May 16, 1988 package.

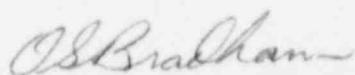
This proposed Technical Specification amendment has been reviewed and approved by both the Plant Safety Review Committee and the Nuclear Safety Review Committee.

The application fee of \$150 required by 10CFR170 is enclosed to initiate processing of this amendment.

SCE&G would appreciate the opportunity to provide a presentation to the NRC Staff on the technical issues surrounding this requested license amendment. A meeting for this purpose can be arranged at your convenience.

Should you have any questions, please advise.

Very truly yours,



O. S. Bradham

AMM/OSB:lcd
Attachments

pc: See Page 6

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