



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 115 TO PROVISIONAL OPERATING LICENSE NO. DPR-13

SOUTHERN CALIFORNIA EDISON COMPANY

SAN DIEGO GAS AND ELECTRIC COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 1

DOCKET NO. 50-206

1.0 INTRODUCTION

By letter dated March 10, 1988 as supplemented March 22 and 29, 1988, Southern California Edison Company (SCE or the licensee) requested a change to the Technical Specifications appended to Provisional Operating License No. DPR-13 for operation of San Onofre Nuclear Generating Station, Unit No. 1 in San Diego County, California. The proposed amendment would revise the steam generator tube plugging criteria to allow tubes with defects in the rolled region of the tubesheet to remain in service provided that the first inch of such tubes contains no imperfections.

2.0 BACKGROUND

On February 16, 1988, the licensee shut down Unit 1 to begin a mid-cycle outage that included an inspection of the steam generator tubes. The inspection, which involved all three of the Model 27 Westinghouse steam generators, revealed that some defects exist in the rolled region of the steam generator tubes in the tubesheet. As a result of this discovery, SCE requested Westinghouse to perform an analysis to determine the amount of tube roll that is actually required to meet all regulatory requirements, as opposed to 2" of roll actually present. This amount of roll is designated the F* distance (1). A similar analysis has been performed on the Haddam Neck plant which also has Model 27 steam generators and is therefore similar in design. The analysis for San Onofre Unit 1 used the Haddam Neck analysis as reference which was accepted by NRC in a safety evaluation dated July 30, 1986 and in Amendment No. 96 to the Haddam Neck operating license (Docket No. 50-213).

(1) The F* distance is defined as the length of continuous undegraded tube expansion in the tubesheet such that tube pullout would not occur during normal or postulated accident loading conditions.

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The licensee requested that NRC expedite its review in order to avoid having to plug 46 tubes which, absent the amendment, would require to be plugged before startup. Interim approval was granted by Amendment No. 101 dated May 6, 1988. This safety evaluation addresses permanent approval and involves the same safety considerations as were involved in the interim approval.

3.0 DISCUSSION

The amendment would continue to allow operation with tube degradation in excess of the current plugging limits when the degradation is located in the tubesheet below the F^* distance.

The criteria for determining whether steam generator tube plugging and repair are required are described in Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes." This Regulatory Guide indicates three factors should be considered when establishing tube degradation limits. They are (1) the minimum tube wall thickness needed in order for tubes with defects to sustain the imposed loadings under normal operating conditions and postulated accident conditions, (2) an operational allowance for degradation between inspections, and (3) the crack size required to ensure the leakage per steam generator does not exceed the technical specification limit. To determine the minimum wall thickness, the RG requires a margin of safety of not less than three against the tube rupture under normal operating conditions, and the margin of safety required against tube failure under postulated accident conditions should be consistent with the margin of safety determined by the stress limits specified in NB-3225 of Section III of the ASME Code.

The San Onofre Unit 1 steam generator tubes were fabricated with a 2-inch depth hardroll of the tubes within the tubesheet at the bottom of the tubesheet and a tube-to-tubesheet weld at the end of the tube. When tubes are fabricated with a hardroll, a transition region exists between the unrolled and fully expanded tube. In the definition of F^* , the bottom of the hardroll means the location where the tube has been fully expanded below the transition region. In lieu of meeting wall thickness limitations, the F^* criterion establishes the length of fully expanded hardroll tube required to meet the wall thickness margins of safety required by RG 1.121.

4.0 EVALUATION

The presence of the tubesheet will enhance the tube integrity in the region of the hardroll by precluding tube deformation beyond the initial expanded outside diameter. The resistance to both tubesheet rupture and tube collapse is strengthened by the presence of the tubesheet in that region. The result of the hardroll of the tube into the tubesheet is an interference fit between the tube and the tubesheet. This interference fit produces an elastic preload between the tube and the tubesheet. Tube rupture can not occur because the contact between the tube and tubesheet does not permit sufficient movement of the tube material. In a similar manner, the tubesheet does not permit sufficient movement of tube

material to permit buckling collapse of the tube during postulated LOCA loadings. Thus, the only method of significantly damaging the pressure boundary provided by the tube is pullout of the tube from the tubesheet. In hardrolled tubes, pullout is resisted by frictional force resulting from (1) the elastic preload between the tube and tubesheet, (2) thermal expansion, and (3) internal pressure. For the San Onofre 1 design, frictional forces are increased by tubesheet bowing. Westinghouse has laboratory tested steam generator tubing to determine the elastic preload caused by hardrolling. Forces resulting from thermal expansion, internal pressure and tubesheet bowing were determined analytically. Using a conservative coefficient of friction between the tube and tubesheet, Westinghouse has determined the net axial resistance to tube pullout for normal and faulted conditions. These net axial resistance forces were used to determine the hardrolled tube length required to meet the RG 1.121 safety margins against tube rupture during normal operation conditions and tube failure under postulated accident conditions. The F* length includes (1) the distances required to meet RG 1.121 safety margins against tube rupture and failures, (2) a distance to account for eddy current measurement uncertainty and (3) a distance to account for reduced preload from material discontinuity at the hardroll transition and the postulated circumferential through-wall flaw. The Westinghouse analysis demonstrates that the F* distance produces sufficient frictional forces to meet the margins of safety required by 1.121 and uncertainties in eddy current testing and material discontinuities.

In lieu of determining an operational allowance for degradation between inspections, the analysis postulated circumferential flaws propagated to a through-wall depth for 360 degrees around the tube. This results in a conservative estimation of flaw growth and precludes the need to determine operational allowances for degradation between inspections.

The F* distance of roll expansion, which contains undegraded tubing, ^{2/} will prevent significant primary to secondary leakage from through-wall flaws located below the F* distance. The existing Technical Specification leakage rate requirements and accident analysis assumptions remain unchanged in the unlikely event that significant leakage from this region does occur. As noted above, the tube rupture and subsequent tube pullout is not expected for a tube using the F* criteria. Any leakage out of the tube from within the tubesheet at any elevation in the tubesheet is fully bounded by the existing steam generator tube rupture analysis. The proposed F* criteria do not adversely impact any other previously evaluated design basis accident.

Based on the above, we conclude that the proposed changes to the steam generator tube plugging surveillance limits meet the safety margins and intent of RG 1.121. Also, the other related Technical Specification changes proposed by the licensee are acceptable. In particular, the Technical Specifications do not allow any imperfections in the F* distance itself.

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In fact, a very strict criteria applies to the F* distance: no imperfections in this distance are allowed, including eddy current testing indications that are detectable even if below 20% of tube wall thickness.

5.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an environmental assessment and finding of no significant impact have been prepared and published in the Federal Register on September 22, 1988 (53 FR 36925). Accordingly, based upon the environmental assessment, the Commission has determined that the issuance of this amendment will not have a significant effect on the quality of human environment.

6.0 CONCLUSION

We have 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 this amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Dated: November 28, 1988