

REACTOR COOLANT SYSTEM

SURVEILLANCE REQUIREMENTS (Continued)

9. Preservice Inspection means an inspection of the full length of each tube in each steam generator performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed after the field hydrostatic test and prior to initial POWER OPERATION using the equipment and techniques expected to be used during subsequent inservice inspections.
10. F* Distance is the distance into the tubesheet from the face of the tubesheet or the top of the last hardroll, whichever is lower (further into the tubesheet) that has been conservatively chosen to be 1.6 inches.
11. F* TUBE is the tube with degradation ^{below the F* distance,} equal to or greater than 40%, ~~below the F* distance~~ and not degraded (i.e., no indications of cracking) within the F* distance. ~~The application of F* expires at the end of the fifth fuel cycle.~~
- b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug or repair all tubes exceeding the plugging limit) required by Table 4.4-2.
- 4.4.5.5 Reports
- a. Within 15 days following the completion of each inservice inspection of steam generator tubes, the number of tubes plugged or repaired in each steam generator shall be reported to the Commission in a Special Report pursuant to Specification 6.9.2.
- b. The complete results of the steam generator tube inservice inspection shall be submitted to the Commission in a Special Report pursuant to Specification 6.9.2 within 12 months following the completion of the inspection. This Special Report shall include:
1. Number and extent of tubes inspected.
 2. Location and percent of wall-thickness penetration for each indication of an imperfection.
 3. Identification of tubes plugged or repaired.
- c. Results of steam generator tube inspections which fall into Category C-3 and require prompt notification of the Commission shall be reported pursuant to 10 CFR 50.72(b)2(i) prior to resumption of plant operation. A report pursuant to 10 CFR 50.73(a)2(ii) shall be submitted to provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.
- d. The results of inspections of F* tubes shall be reported to the Commission in a report to the Director, ONRR, prior to the restart of the unit following the inspection. This report shall include:
1. Identification of F* tubes, and
 2. Location and size of the degradation
- NRC approval of this report is not required prior to restart.

ATTACHMENT 2

Description of Amendment Request and Safety Evaluation

Description of Amendment Request:

Technical Specification 4.4.5.a.11, "Acceptance Criteria-F* Tube," presently allows use of the F* criterion on steam generator tubes until the end of the fifth fuel cycle. The requested Technical Specification change will allow use of the F* criterion for the remaining life of the steam generators by removing reference to an expiration time. In addition, an editorial change was made to the F* tube definition to provide clarification without altering the technical content.

The basis for steam generator tube surveillance and plugging/repair is to ensure that the structural integrity of the tubes is maintained. The F* criterion was developed to preclude unnecessary tube plugging by allowing tubes with degradation below the F* distance (i.e., degradation below a specified sound tube distance in the tubesheet) to remain in service. Tube degradation below the F* distance was determined to have minimal impact on the tube integrity and leakrate because of the characteristics of the tube to tubesheet interface.

The proposed Technical Specification change is requested to provide SCE&G with an alternative for dispositioning degraded steam generator tubes. Use of the F* criterion provides benefits by maintaining tube heat transfer capabilities and reducing personnel radiation exposure obtained during plugging/sleeving operations.

Safety Evaluation:

I. Introduction

The F* criterion was developed to allow steam generator tubes to remain in service when degradation has been detected in the full depth hard roll expanded portion of the tube in the tubesheet below the "F*" distance (1.6"). If the F* criterion were not in use for VCSNS, defects below the F* distance would require the affected tubes to be plugged. Based on technical considerations, such plugging is not necessary. The presence of the tubesheet constrains the tube and compliments its integrity in the hard rolled region by precluding tube deformation beyond its expanded outside diameter. The resistance to both tube rupture and tube collapse is significantly strengthened by the tubesheet. In addition, the intimate contact between the tube and the tubesheet affects the leak behavior of any potential throughwall tube cracks in this region, i.e., no significant leakage relative to plant technical specification allowables has been experienced.

The technical basis for establishing the F* criterion has been presented previously in Westinghouse Reports WCAP 11228 (proprietary) and 11229 (non-proprietary). The F* criterion identifies a distance below the face of the tubesheet or the top of the last hardroll, whichever is further in the tubesheet, and designates that distance F*. Below F*, tube degradation of any extent does not necessitate plugging. To date, the F* criterion has been utilized during both the third and fourth refueling outages at VCSNS. The information

presented below justifies continuing the application of the F* criterion for the remaining life of the steam generators.

II. Approach

As noted in Section I, the technical justification for use of the F* criterion has been demonstrated previously (reference HCAP-11228 submitted to the NRC in a letter dated October 20, 1986, from Mr. D. A. Nauman to Mr. Harold R. Denton, and the subsequent NRC SER to support Amendment 54 to the VCSNS Technical Specifications). To date, no new test data or information has been presented by the developer of the F* criterion which influences the original technical justification for the F* criterion. In addition, no adverse effects of the application of the F* criterion at VCSNS or any other plant have been identified to date. Accordingly, the originally submitted justification is considered still to be applicable and to provide justification for continued use of the F* criterion. Furthermore, the following approaches have been used to provide further evidence that continued use of the F* criterion at VCSNS is justified:

1. Review of VCSNS Data - Eddy current inspection results, tube plugging data, and tube leakrate data were reviewed to determine the effect, if any, of the F* criterion on tube plugging requirements and leakage rates. Inspection results were also utilized to determine actual trends in tube degradation since implementation of the F* criterion, as well as predicted trends in degradation had the F* criterion not been utilized.
2. Review of Industry Data - Eddy current inspection results and related data from other units incorporating the F* criterion or similar approaches were reviewed for their applicability to VCSNS. These results were used to further understand the effects of the F* criterion on tube plugging requirements and leakage rates.

III. Justification

1. Review of VCSNS Data

A. Review of Eddy Current (EC) Inspection Data

The SCE&G submittals dated May 15, 1987, and December 6, 1988, document inspection results on F* tubes. While some crack growth may occur, the growth appears to be arrested at the end of the "skip roll" region where the residual stresses are relieved.

B. Review of Tube Leakage Data

A review of primary coolant leakrates for VCSNS over the period the F* criterion has been in use indicates that leakrates have remained well below the limits specified by the plant technical specifications. In addition, the leakrate data indicates that no significant increases,

transients, or abnormalities in the leakrates have been associated with the tubes which have remained in service due to the F* criterion.

C. Other Possible Effects of the F* Criterion

A review of the ECT data for VCSNS and other related plants indicates no adverse effects on tubesheet integrity caused by degraded tubes remaining in service below the F* region. However, if degraded tubes were to leak and cause degradation of the tubesheet material, corrosion products would result in constriction of the tube within the tubesheet at that location. No evidence of such tube constriction has been identified in any operating plant.

2. Review of Industry Data

A. Review of EC Inspection Data

Several other operating plants in the United States and overseas are presently utilizing an alternate plugging criterion similar to the F* criterion being used at VCSNS. These units are, in general, similar in design and operation to VCSNS (Westinghouse Model D steam generators). A review of EC inspection results for these plants indicates that the impact of the alternate criterion on tube plugging status has been approximately equal to the impact of the F* criterion at VCSNS. To date, no abnormal EC indication or primary to secondary leaks associated with the tubes left in service due to the alternate criterion have been noted.

B. Review of Tube Leakrate Data

A review of tube leakrate data from other plants presently utilizing the alternate plugging criterion for tubesheet region degradation indicates that no significant increases, transients, or abnormalities in leakrates have been associated with the tubes which have remained in service due to the alternate plugging criterion.

3. Impact of F* Criterion on Steam Generator Plugging Status

A. Impact of F* to Date

As noted previously, use of F* criterion has been of significant benefit in limiting the number of tubes plugged due to degradation in the tubesheet region in the VCSNS steam generators. The 369 tubes left in service using F* criterion at VCSNS represented 63% of the potentially pluggable tubes identified during the last refueling outage (Refuel 4). To date, degradation of tubes has resulted in a cumulative plugging of 7.8% in the VCSNS steam generators. If the F* criterion had not been implemented, cumulative plugging due to degradation would currently be 10.4%.

In addition, if the F* criterion had not been implemented, the total personnel exposure would have been higher. As noted above, 369 tubes over the three steam generators currently have the F* criterion applied. Had these tubes required plugging, an additional estimated personnel exposure of 9.225 man-rem would have occurred. (This estimate is based on utilization of robotics to perform the plugging; substantially greater exposures would have been realized had manual plugging been assumed.) Continued application of the F* criterion will further maintain doses ALARA as time progresses and additional tubes are affected.

B. Impact of F* Criterion on Future Tube Plugging Requirements

Hot leg tube sheet degradation may decline from present rates because of peening, but the ratio of tubes plugged to F* tubes are estimated to remain approximately the same. Therefore, F* will continue to be effective in preventing unnecessary tube plugging.

In addition, cold leg tubesheet region cracking has been detected in the VCSNS steam generators. The same mechanism is at work on the cold leg tubesheet region; however, the reduced temperature significantly slows the process. It is anticipated that the F* criterion applied to the cold leg tubesheet region will significantly reduce the number of tubes which will require plugging due to degradation in this region.

IV. Summary

From the information presented in Section III, the following conclusions are made regarding the implementation and use of the F* criterion at VCSNS:

- A. Use of the F* criterion at VCSNS has had no adverse impact on any aspect of steam generator operability. No significant change in primary to secondary coolant leakrates have been observed, and no degradation of tubesheet material has been identified as a result of the F* criterion.
- B. Other plants similar in design and operation to VCSNS have successfully implemented an alternate plugging criterion such as F* with no adverse effects on steam generator operability.
- C. The F* criterion has had, and is expected to continue to have, a significant positive impact on overall tube plugging status in the VCSNS steam generators.
- D. It is considered that these findings represent sufficient justification for including the F* criterion as a permanent part of TS 3/4.4.5, "Steam Generators." In addition, it is considered that the information presented in Section III represents

sufficient evidence that the F* criterion is functioning safely and effectively.

- E. The F* criterion has had, and will have, a positive impact on the plant reduction of personnel radiation exposure for the life of the plant.

ATTACHMENT 3

Description of Amendment Request and
No Significant Hazards Evaluation

NO SIGNIFICANT HAZARDS EVALUATION

Description of Amendment Request:

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The basis for steam generator tube surveillance and plugging/repair is to ensure that the structural integrity of the tubes is maintained. The F* criterion was developed to preclude unnecessary tube plugging by allowing tubes with degradation below the F* distance (i.e., degradation below a specified sound tube distance in the tubesheet) to remain in service. Tube degradation below the F* distance was determined to have minimal impact on the tube integrity and leakrate because of the characteristics of the tube to tubesheet interface.

The proposed Technical Specification change is requested to provide SCE&G with an alternative for dispositioning degraded steam generator tubes. Use of the F* criterion provides benefits by maintaining tube heat transfer capabilities and reducing personnel radiation exposure obtained during plugging/sleeving operations.

No Significant Hazards Evaluation:

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The technical basis for establishing the F* criterion has been presented previously in Westinghouse Reports WCAP 11228 (proprietary) and 11229 (non-proprietary). The F* criterion identifies a distance below the face of the tubesheet or the top of the last hardroll, whichever is further in the tubesheet, and designates that distance F*. Below F*, tube degradation of any extent does not necessitate plugging. The F* criterion has been utilized during both the third and fourth refueling outages at VCSNS. To date, no

significant change in primary to secondary coolant leakrates have been observed and no degradation of tubesheet material has been identified as a result of the F* criterion. Also, no new test data or information has been presented by the developer of the F* criterion which influences the original technical justification for the F* criterion. In summary, use of the F* criterion at VCSNS and similar alternate plugging criterion at other plants has had no identified adverse impact on steam generator operability.

Pursuant to 10CFR50.91, the following analyses provide a determination that the proposed amendment does not involve significant hazards as defined by 10CFR50.92.

- 1) The proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

As described above, the utilization of the F* criterion does not impact the operability of the steam generators. The restraining action of the tubesheet upon the tubes precludes tube rupture or collapse for F* tubes and the tube to tubesheet interface restricts the potential for primary to secondary leakage.

The prevention of tube rupture by the tubesheet assures the probability of the steam generator tube rupture accident is unaffected, while the restriction of leakage assures that the consequences of any accident are not significantly affected by the application of F*.

- 2) The proposed amendment would not create the possibility of a new or different kind of accident previously evaluated.

The proposed changes continue to ensure the integrity of the steam generator tubes and the tubesheet. Use of the F* criterion does not alter the tube function or original failure mechanisms. Furthermore, testing and operational experience have shown that the affected tubes behave as expected with no significant change in leakrates or tubesheet degradation. Therefore, the possibility of a new or different kind of accident is not created.

- 3) The proposed amendment would not involve a significant reduction in a margin of safety.

The proposed changes extend the use of the F* criterion for the life of the steam generator. Testing and operational experience have revealed that the affected tubes behave as expected, i.e., remain restrained by the tubesheet with no significant leakage, and do not present a safety concern.

Additionally, the NRC has previously found the F* criterion to be acceptable at VCSNS, pending confirmation of tube behavior through two cycles of operation. Documentation to date supports the behavior of F* tubes has been as expected. Proper application of the F* criterion has been demonstrated to not have an adverse effect on the integrity of the generators, thus the F* criterion may be extended for the life of the steam generators without decreasing plant safety.

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December 11, 1989
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In addition, the grammatical restructuring of the F* definition is purely editorial in nature and has no technical impact. Based upon the preceding analysis, SCE&G concludes that the proposed change does not involve a significant hazards consideration.