

REACTOR COOLANT SYSTEM

3/4.4.6 STEAM GENERATORS

LIMITING CONDITION FOR OPERATION

3.4.6 Each steam generator shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With one or more steam generators inoperable, restore the inoperable generator(s) to OPERABLE status prior to increasing T_{avg} above 200°F.

SURVEILLANCE REQUIREMENTS

4.4.6.0 Each steam generator shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirements of Specification 4.0.5.

4.4.6.1 Steam Generator Sample Selection and Inspection - Each steam generator shall be determined OPERABLE during shutdown by selecting and inspecting at least the minimum number of steam generators specified in Table 4.4-1.

4.4.6.2.1 Steam Generator Tube[#] Sample Selection and Inspection - The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.4-2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.4.6.3 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.4.6.4. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators. Selection of tubes to be inspected is not affected by the F₂ designation. When applying the exceptions of 4.4.6.2.1.a through 4.4.6.2.1.c, previous defects or imperfections in the area repaired by sleeving are not considered an area requiring reinspection. The tubes selected for these inspections shall be selected on a random basis except:

- a. Where experience in similar plants with similar water chemistry indicates critical areas to be inspected, then at least 50% of the tubes inspected shall be from these critical areas.
- b. The first sample of tubes selected for each inservice inspection (subsequent to the preservice inspection) of each steam generator shall include:
 - 1. All nonplugged tubes that previously had detectable wall penetrations greater than 20%.

#When referring to a steam generator tube, the sleeve shall be considered a part of the tube if the tube has been repaired per Specification 4.4.6.4.2.9.

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SURVEILLANCE REQUIREMENTS (Continued)

| Category | Inspection Results |
|----------|--|
| C-1 | Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective. |
| C-2 | One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes. |
| C-3 | More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective. |

Note: In all inspections, previously degraded tubes or sleeves must exhibit significant (greater than 10%) further wall penetrations to be included in the above percentage calculations.

4.4.6.2.2 Steam Generator R²/L⁴ Tube Inspection - In addition to the minimum sample size as determined by Specification 4.4.6.2.1, all R²/L⁴ tubes will be inspected within the tubesheet region. The results of this inspection will not be a cause for additional inspections per Table 4.4-2.

4.4.6.3 Inspection Frequencies - The above required inservice inspections of steam generator tubes shall be performed at the following frequencies:

- a. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections following service under AVT conditions, not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months.
- b. If the results of the inservice inspection of a steam generator conducted in accordance with Table 4.4-2 at 40 month intervals fall in Category C-3, the inspection frequency shall be increased to at least once per 20 months. The increase in inspection frequency shall apply until the subsequent inspections satisfy the criteria of Specification 4.4.6.3.a; the interval may then be extended to a maximum of once per 40 months.
- c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.4-2 during the shutdown subsequent to any of the following conditions:

This definition does not apply for tubes that meet the F^*/L^* criterion.

6. Plugging or Repair Limit means the imperfection depth at or beyond which the tube shall be repaired (i.e., sleeved) or removed from service by plugging and is ~~greater than or equal to 40% of the nominal tube wall thickness. This definition does not apply to the area of the tubesheet region below the F^* distance in the r -tubes.~~ For a tube that has been sleeved with a mechanical joint sleeve, through wall penetration of greater than or equal to 11% of sleeve nominal wall thickness in the sleeve requires the tube to be removed from service by plugging. For a tube that has been sleeved with a welded joint sleeve, through wall penetration greater than or equal to 37% of sleeve nominal wall thickness in the sleeve between the weld joints requires the tube to be removed from service by plugging. This definition does not apply to tube support plate intersections for which the voltage-based plugging criteria are being applied. Refer to 4.4.6.4.a.14 for the plugging limit applicable to these intersections.
7. Unserviceable describes the condition of a tube or sleeve if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 4.4.6.3.c, above.
8. Tube Inspection means an inspection of the steam generator tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg. For a tube that has been repaired by sleeving, the tube inspection should include the sleeved portion of the tube.
9. Tube Repair refers to mechanical sleeving, as described by Westinghouse report WCAP-11178, Rev. 1, or laser welded sleeving as described by Westinghouse report WCAP-12672, which is used to maintain a tube in service or return a tube to service. This includes the removal of plugs that were installed as a corrective or preventive measure.

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SURVEILLANCE REQUIREMENTS (Continued)

Insert A

11. F* Distance is the distance of the expanded portion of a tube which provides a sufficient length of undegraded tube expansion to resist pullout of the tube from the tubesheet. The F* distance is equal to 1.79 inches and is measured down from the top of the tubesheet or the bottom of the roll transition, whichever is lower in elevation.

12. F* Tube is a tube:

a) with degradation equal to or greater than 40% below the F* distance, and b) which has no indication of imperfections greater than or equal to 20% of nominal wall thickness within the F* distance, and c) that remains inservice.

15. ~~15.~~ Tube Expansion is that portion of a tube which has been increased in diameter by a rolling process such that no crevice exists between the outside diameter of the tube and the hole in the tubesheet.

16. ~~16.~~ Tube Support Plate Repair Limit is used for the disposition of an alloy 600 steam generator tube for continued service that is experiencing predominately axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the repair limit is based on maintaining steam generator tube serviceability as described below:

- a. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to the lower voltage repair limit (2.0 volts), will be allowed to remain in service.
- b. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than the lower voltage repair limit (2.0 volts), will be repaired or plugged except as noted in 4.4.6.4.a.14.c below.

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SURVEILLANCE REQUIREMENTS (Continued)

4.4.6.5 Reports

/L*

- a. Following each inservice inspection of steam generator tubes, the number of tubes plugged, repaired or designated F* in each steam generator shall be reported to the Commission within 15 days of the completion of the inspection, plugging or repair effort.
- b. The complete results of the steam generator tube and sleeve 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 and sleeves 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 shall be considered a REPORTABLE EVENT and shall be reported pursuant to 10CFR50.73 prior to resumption of plant operation. The written report shall provide a description of investigations conducted to determine the cause of the tube degradation and corrective measures taken to prevent recurrence.
- d. For implementation of the voltage-based repair criteria to tube support plate intersections, notify the staff prior to returning the steam generator to service (Mode 4) should any of the following conditions arise:
 1. If estimated leakage based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds the leak limit (determined from the licensing basis dose calculation for the postulated main steam line break) for the next operating cycle.
 2. If circumferential crack-like indications are detected at the tube support plate intersections.
 3. If indications are identified that extend beyond the confines of the tube support plate.
 4. If indications are identified at the tube support plate elevations that are attributable to primary water stress corrosion cracking.
 5. If the calculated conditional burst probability based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds 1×10^{-2} , notify the NRC and provide an assessment of the safety significance of the occurrence.

a. Mechanical

1. Indications of degradation in the entire length of the sleeve must be evaluated against the sleeve plugging limit.
2. Indication of tube degradation of any type including a complete guillotine break in the tube between the bottom of the upper joint and the top of the lower roll expansion does not require that the tube be removed from service.
3. The tube plugging limit continues to apply to the portion of the tube in the entire upper joint region and in the lower roll expansion. As noted above, the sleeve plugging limit applies to these areas also.
4. The tube plugging limit continues to apply to that portion of the tube above the top of the upper joint.

b. Laser Welded

1. Indications of degradation in the length of the sleeve between the weld joints must be evaluated against the sleeve plugging limit.
2. Indication of tube degradation of any type including a complete break in the tube between the upper weld joint and the lower weld joint does not require that the tube be removed from service.
3. At the weld joint, degradation must be evaluated in both the sleeve and tube.
4. In a joint with more than one weld, the weld closest to the end of the sleeve represents the joint to be inspected and the limit of the sleeve inspection.
5. The tube plugging limit continues to apply to the portion of the tube above the upper weld joint and below the lower weld joint.

F* tubes do not have to be plugged or repaired provided the remainder of the tube within the tubesheet that is above the F* distance is not degraded. The F* distance is equal to 1.79 inches and is measured down from the top of the tubesheet or the bottom of the roll transition, whichever is lower in elevation. Included in this distance is an allowance of 0.25 inch for eddy current elevation measurement uncertainty.

*Insert
B* →

Steam generator tube inspections of operating plants have demonstrated the capability to reliably detect wastage type degradation that has penetrated 20% of the original tube wall thickness.

Insert A

12. F* Tube is a tube:

a) with degradation equal to or greater than 40% below the F* distance, and b) which has no indication of imperfections greater than or equal to 20% of nominal wall thickness within the F* distance, and c) that remains inservice.

If the above criteria cannot be met, then the L* tube criteria may be applied or the tube must be plugged or repaired.

13. L* Length is the length of the expanded portion of the tube into the tube sheet from the bottom of the rolled transition or the top of the tube sheet, which ever is lower, that has been measured to be 1.45 inches.

14. L* Tube: a) is a tube with degradation equal or greater than 40% below the L* length and not degraded within the L* length; b) the eddy current indication of degradation below the L* length must be determined to be the result of cracks with an orientation no greater than 15 degrees from axial; c) the L* criteria shall be limited to a maximum of 600 tube ends per steam generator; d) tubes qualifying as F* tubes are not classified as L* tubes; e) a minimum of 3.1 inches of the tube into the tubesheet from the top of tubesheet or bottom of the rolled transition, which ever is lower, shall be inspected using rotating pancake coil eddy current technique or an inspection method shown to give equivalent or better information on the orientation and length of axial cracks; f) a minimum aggregate measured length of 2.07 inches of sound roll expansion; g) a maximum measured crack length of .39 inches; h) a maximum of 5 distinct indications with a single band of tube degradation; and i) that remains in service.

Insert B

L* is similar to F*; however, bands of axial degradation are allowed as long as sufficient non-degraded tubing is available to ensure structural and leakage integrity. Provide below is the Unit 2 Cycle 11 specific L* criterion:

Unit 2 Cycle 11 Specific L* Criterion

| Parameter | Value |
|---|------------------------|
| Minimum distance of SRE | 2.07 inches (measured) |
| Maximum number of distinct degradation areas in a band | 5 |
| Maximum inclination angle of single band | 15 degrees (measured) |
| Maximum crack length | .39 inches (measured) |
| Minimum distance of SRE from the bottom of the transition roll to the top of the indication | 1.45 inches (measured) |