4.17   STEAM GENERATOR TUBING SURVEILLANCE

Applicability

Applies to the surveillance of tubing of each steam generator.

Objective

To ensure integrity of the steam generator tubing through a defined inservice surveillance program, and to minimize exposure of personnel to radiation during performance of the surveillance program.

Specification

4.17.1   Examination Methods

Inservice inspection of steam generator tubing shall include non-destructive examination by eddy-current testing or other equivalent techniques. The inspection equipment shall provide a sensitivity that will detect defects and a penetration of 20 percent or more of the minimum allowable as-manufactured tube wall thickness.

4.17.2   Acceptance Criteria

The steam generator shall be considered operable after completion of the specified actions. All tubes examined exceeding the plugging limit shall be removed from service (e.g., plugged, stabilized).

4.17.3   Selection and Testing

The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.17.1. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.17.4 and the inspected tubes shall be verified acceptable per Specification 4.17.5. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in both steam generators. The tubes selected for these inspections shall be selected on a random basis except:

a.   The first sample inspection during each inservice inspection of each steam generator shall include:

   1.   All nonplugged tubes that previously had detectable wall penetrations (>20%), and

   2.   At least 50% of the tubes inspected shall be in those areas where experience has indicated potential problems.

   3.   A tube adjacent to any selected tube which does not permit passage of the eddy current probe for tube inspection.

b.   Tubes in the following Group(s) may be excluded from the first sample if all tubes in a Group in both OTSG are inspected. No credit will be taken for these tubes in meeting minimum sample size requirements.

(1) Group A-1: Tubes within one, two, or three rows of the open inspection lane.

c. The second and third sample inspections during each inservice inspection as required by Table 4.17-1 may be less than a full tube inspection by concentrating the inspection on those areas of the tube sheet array and on those portions of the tubes where tubes with imperfections were previously found.

The results of each sample inspection shall be classified into one of the following three categories:

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.

NOTES: (1) In all inspections, previously degraded tubes must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

(2) Where special inspections are performed pursuant to 4.17.3.b, defective or degraded tubes found as a result of the inspection shall be included in determining the Inspection Results Category for that special inspection but need not be included in determining the Inspection Results Category for the general steam generator inspection.

4.17.4 Inspection Intervals

The above required inservice inspections of steam generator tubes shall be performed at the following frequencies.

a. Inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If the results of two consecutive inspections following service under all volatile treatment (AVT) conditions fall 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 40 months.

b. If the results of the inservice inspection of a steam generator performed in accordance with Table 4.17-1 at 40 month intervals fall in Category C-3, subsequent inservice inspections shall be performed at intervals of not less

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than 10 months nor more than one fuel cycle after the previous inspection. The increase in inspection frequency shall apply until a subsequent inspection meets the conditions specified in 4.17.4.a and the interval can be extended to 40 months.

c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.17-1 during the shutdown subsequent to any of the following conditions:

   1. A seismic occurrence greater than the Operating Basis Earthquake,

   2. A loss-of-coolant accident requiring actuation of the engineered safeguards, or

   3. A main steam line or feedwater line break.

d. After primary to secondary leakage in excess of the limits of Specification 3.1.6, additional inspections will be performed in accordance with the following criteria.

   1. If the leaking tube is in a Group as defined in Section 4.17.3.b, or is in a degraded tube all of the tubes in this Group will be inspected.

   2. If the leaking tube is not in a Group as defined in 4.17.4.d.1, then an additional inspection will be performed on the affected steam generator in accordance with Table 4.17-1 (i.e., a minimum of S tubes in the affected steam generator.

4.17.5   Definitions

As used in this specification:

a. <u>Imperfection</u> means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

b. <u>Degradation</u> means a service-included cracking, wastage, wear or general corrosion occurring on either the inside or outside of a tube.

c. <u>Degraded Tube</u> means a tube containing imperfections $\geq$20% of the nominal wall thickness caused by degradation.

d. <u>% Degradation</u> means the percentage of the tube wall thickness affected or removed by degradation.

e. <u>Defect</u> means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective.

f. <u>Plugging Limit</u> means the imperfection depth beyond which the tube shall be removed from service because it may become unserviceable prior to the next inspection; it is equal to 40% of the nominal tube wall thickness.

g. <u>Unserviceable</u> describes the condition of a tube if it leaks or contains

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a defect large enough to affect its structural integrity in the event of an Operating Basis Eqrthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in Specification 4.17.4.

h.   Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit.

4.17.6   Reports

a.   Following each inservice examination of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the Director, Office of Inspection and Enforcement, Region II within 30 days.

b.   The results of the steam generator tube inservice inspection shall be reported to the NRC within 3 months following completion of the inspection. This report shall include:

1.   Number and extent of tubes inspected.

2.   Location and percent of wall-thickness penetration for each indication of a degraded tube.

3.   Identification of tubes plugged.

Bases

The program of periodic inservice inspection of steam generators provides the means to monitor the integrity of the tubing and to maintain surveillance in the event there is evidence of mechanical damage or progressive deterioration due to design, manufacturing errors, or operating conditions. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures may be taken.

Removal from service will be required for any tube with service-included metal loss in excess of 40% of the tube nominal wall thickness or with a circumferential crack. Additional corrective actions may be required to stabilize a circumferentially cracked tube.

The initial sample of tubes inspected in a steam generator includes tubes from three groups. First, lane tubes are inspected to assure their integrity. Second, all other inservice tubes with degradation, inspected in previous inspections, are inspected to assure tube integrity and determine degradation growth, if any. Third, a 3% random sample of tubes is inspected. The results of the latter inspection dictate the extent of further examinations.

TABLE 4.17-1

STEAM GENERATOR TUBE INSPECTION[2]

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action	Result	Action
A minimum of S Tubes per S.G. (1)	C-1	None	N/A	N/A	N/A	N/A
	C-2	Plug defective tubes and inspect additional 2S tubes in this S. G.	C-1	None	N/A	
			C-2	Plug defective tubes & inspect additional 4S tubes in this S. G.	C-1	N/A
					C-2	Plug defective tubes
					C-3	Plug defective tubes and perform action for C-3 rusult of 1st Sample
			C-3	Plug defective tubes and perform actions for C-3 result of 1st Sample	N/A	N/A
	C-3	Plug defective tubes and inspect additional 4S tubes in the affected S. G. and inspect 2S tubes in the other steam generator.	C-1	None	N/A	N/A
			C-2	Plug defective tubes and perform action for C-2 result of 2nd Sample.	N/A	N/A
			C-3	Plug defective tubes and perform additional inspection as follows: a) If the extent of the affected area can be determined inspect all tubes in this area. b) If the degradation appears random inspect an additional 4S tubes in the S. G.	C-1	None
					C-2	Plug defective tubes
					C-3	Plug defective tubes and perform additional inspections as follows: a) If the extent of the affected area can be determined inspect all tubes in this area. b) If the degradation appears random inspect all tubes in this S. G.

Notes: (1) $S = 3\frac{N}{n}\%$ Where N is the number of steam generators in the unit, and n is the number of steam generators inspected during an inspection.

(2) For tubes inspected pursuant to 4.17.3: 1 No action is required for C-1 results. For C-2 results in one or both steam generators plug defective tubes. For C-3 results in one or both steam generators, plug defective tubes and provide prompt notification of NRC.