

#### 4.18 STEAM GENERATOR TUBING SURVEILLANCE

##### Applicability

Applies to the surveillance of tubing of each steam generator.

##### Objective

To define the inservice surveillance program for steam generator tubing.

##### Specification

##### 4.18.1 Baseline Inspection

The first steam generator tubing inspection performed according to Specifications 4.18.2 and 4.18.3 shall be considered as constituting the baseline condition for subsequent inspections.

##### 4.18.2 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 with a penetration of 20 percent or more of the minimum allowable as-manufactured tube wall thickness.

##### 4.18.3 Selection and Testing

The steam generator sample size is specified in Table 4.18.1. The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.18.2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.18.4 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.18.5. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators; 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 of the tubes inspected shall be from these critical areas.
- b. The first inservice inspection (subsequent to the baseline inspection) of each steam generator shall include:
  1. All nonplugged tubes that previously had detectable wall penetrations (>20%), and
  2. Tubes in those areas where experience has indicated potential problems.

- c. The second and third inservice inspections may be less than a full tube inspection by concentrating (selecting at least 50% of the tubes to be inspected) 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:

| <u>Category</u> | <u>Inspection Results</u>  |
|-----------------|--|
| 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 must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

#### 4.18.4 Inspection Intervals

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

- a. The baseline inspection shall be performed during the first refueling shutdown. Subsequent inservice inspections shall be performed at intervals of not less than 10 nor more than 24 calendar months after the previous inspection. If two consecutive inspections following service under all volatile treatment (AVT) conditions 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 inservice inspection of a steam generator conducted in accordance with Table 4.18.2 requires a third sample inspection whose results fall in Category C-3, subsequent inservice inspections shall be performed at intervals of not less than 10 nor more than 20 calendar months after the previous inspection. The reduction in inspection frequency shall apply until a subsequent inspection demonstrates that a third sample inspection is not required.

- c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.18.2 during the shutdown subsequent to any of the following conditions.
1. Primary-to-secondary leakage in excess of the limits of Specification 3.10 (inservice inspection not required if leaks originate from tube-to-tube sheet welds),
  2. A seismic occurrence greater than the Operating Basis Earthquake,
  3. A loss-of-coolant accident requiring actuation of the engineered safeguards, or
  4. A main steam line or feedwater line break.

#### 4.18.5 Acceptance Criteria

- a. As used in this specification:
1. Imperfection 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.
  2. Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.
  3. Degraded Tube means a tube containing imperfections  $\geq 20\%$  of the nominal wall thickness caused by degradation.
  4. % Degradation means the percentage of the tube wall thickness affected or removed by degradation.
  5. Defect means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective. Any tube which does not permit the passage of the eddy-current inspection probe shall be deemed a defective tube.
  6. Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service because it may become unserviceable prior to the next inspection and is equal to 50% of the nominal tube wall thickness.
  7. Unserviceable describes the condition of a tube 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 Specification 4.18.4.c.

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

- b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 4.18.2.

#### 4.18.6 Reports

Following each inservice inspection of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the NRC per Specification 6.12.3. Results of steam generator tube inspections which fall into Category C-3 and require prompt notification of the NRC shall be reported per Specification 6.12.3.

#### Bases

The surveillance requirements for inspection of the steam generator tubes ensure that the structural integrity of this portion of the RCS will be maintained. The program for inservice inspection of steam generator tubes is based on a modification of Regulatory Guide 1.83, Revision 1. Inservice inspection of steam generator tubing is essential in order to maintain surveillance of the conditions of the tubes in the event that there is evidence of mechanical damage or progressive degradation due to design, manufacturing errors, or inservice conditions that lead to corrosion. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken.

TABLE 4.18-1

MINIMUM NUMBER OF STEAM GENERATORS TO BE  
INSPECTED DURING INSERVICE INSPECTION

|   |                  |
|---|------------------|
| Preservice Inspection                     | No               |
| No. of Steam Generators per Unit          | Two              |
| First Inservice Inspection                | Two              |
| Second & Subsequent Inservice Inspections | One <sup>1</sup> |

Table Notation:

1. The inservice inspection may be limited to one steam generator on alternating schedule encompassing  $3 N \%$  of the tubes (where N is the number of steam generators in the plant) if the results of the first or previous inspections indicate that all steam generators are performing in a like manner. Note that under some circumstances, the operating conditions in one or more steam generators may be found to be more severe than those in other steam generators. Under such circumstances the sample sequence shall be modified to inspect the most severe conditions.

TABLE 4.18-2

## STEAM GENERATOR TUBE INSPECTION

| 1ST SAMPLE INSPECTION              |        |  | 2ND SAMPLE INSPECTION       |   | 3RD SAMPLE INSPECTION |   |
|------------------------------------|--------|--|-----------------------------|---|-----------------------|---|
| Sample Size                        | Result | Action Required  | Result                      | Action Required   | Result                | Action Required   |
| A minimum of<br>S Tubes per<br>S.G | C-1    | None   | N/A                         | N/A   | N/A                   | N/A   |
|                                    | C-2    | Plug defective tubes<br>and inspect addi-<br>tional 2S tubes in<br>this S.G.<br><br>Notify NRC pursuant<br>to Specification<br>6.12.3  | C-1                         | None  | N/A                   | N/A   |
|                                    |        |  | C-2                         | (II) Plug defective<br>tubes and in-<br>spect additional<br>4S tubes in this<br>S.C.<br><br>Notify NRC pur-<br>suant to Specifi-<br>cation 6.12.3 | C-1                   | None  |
|                                    |        |  |                             |   | C-2                   | Plug defective tubes<br>Notify NRC pursuant<br>to Specification<br>6.12.3 |
|                                    |        |  | C-3                         | Perform action for<br>C-3 result of first<br>sample (See I)   |                       |   |
|                                    | C-3    | Perform action<br>for C-3 result of<br>first sample(See I)   | N/A                         | N/A   |                       |   |
|                                    | C-3    | (I) Inspect all tubes<br>in this S.G.,<br>plug defective<br>tubes and inspect<br>2S tubes in the<br>other S.G.<br><br>Prompt notification<br>to NRC pursuant to<br>specification<br>6.12.3 | The other<br>S.G. is<br>C-1 | None  | N/A                   | N/A   |
|                                    |        |  | Other S.G.<br>is C-2        | Perform action<br>for C-2 result<br>of second sample<br>(See II)  | N/A                   | N/A   |
|                                    |        |  | Other S.G.<br>is C-3        | Inspect all tubes<br>in each S.G. and<br>plug defective<br>tubes. Prompt<br>notification to<br>NRC pursuant to<br>specification<br>6.12.3         | N/A                   | N/A   |

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

The dose assignment to various duty functions may be estimates based on pocket dosimeter, TLD, or film badge measurements. Small exposures totalling less than 20% of the individual total dose need not be accounted for. In the aggregate, at least 80% of the total whole body dose received from external sources shall be assigned to specific major work functions.

- (d) Indications of failed fuel resulting from irradiated fuel examinations, including eddy current tests, ultrasonic tests, or visual examinations completed during the report period.
- (e) The complete results of the steam generator tube inservice inspection. The results 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.

#### 6.12.2.3 Monthly Operating Report

Routing reports of operating statistics and shutdown experience shall be submitted on a monthly basis to the Director, Office of Management Information and Program Control, U. S. Nuclear Regulatory Commission, Washington, D.C. 20555, with a copy to the appropriate Regional Office, by the tenth of each month following the calendar month covered by the report.

#### 6.12.3 Reportable Occurrences

Reportable occurrences, including corrective actions and measures to prevent recurrence, shall be reported to the NRC as required below. Supplemental reports may be required to fully describe final resolution of occurrence. In case of corrected or supplemental reports, a licensee event report shall be completed and reference shall be made to the original report date.

##### 6.12.3.1 Prompt Notification With Written Followup

The types of events listed below shall be reported as expeditiously as possible, but within 24 hours, by telephone and confirmed by telegraph, mailgram, or facsimile transmission to the Director of the appropriate Regional Office, or his designate no later than the first working day following the event, with a written followup report within two weeks. A copy of the confirmation and the written followup report shall also be sent to the Director, Office of Management Information and Program Control, USNRC. The written report shall include, as a minimum, a completed copy of a licensee event report form. Information provided on the licensee event report form shall be supplemented, as needed, by additional narrative material to provide complete explanation of the circumstances surrounding the event.

- (a) Failure of the reactor protection system or other systems subject to limiting safety system settings to initiate the required protective function by the time a monitored parameter reaches the setpoint specified as the limiting safety system setting in the Technical Specifications or failure to complete the required protective function.

NOTE:

Instrument drift discovered as a result of testing need not be reported under this item but may be reportable under items (e), (f), or 6.12.3.2(a).