INSPECTABLE AREA: Inservice Inspection Activities

CORNERSTONES: Initiating Events (30%)
Mitigating Systems (40%)
Barrier Integrity (30%)

INSPECTION BASES: Inservice inspection (ISI) activities can detect precursors to pressure boundary failures in reactor coolant system (RCS), emergency core cooling systems (ECCS), risk-significant piping and components, and containment system. Degradation of pressure boundaries of the reactor coolant system, steam generator tubes, emergency feedwater system, essential service water system, and containment would result in a significant increase in risk. This inspection is intended to assess the effectiveness of the licensee's program for monitoring degradation of vital system boundaries. This inspectable area verifies aspects of the Initiating Events, Mitigating Systems, and Barrier Integrity cornerstones.

LEVEL OF EFFORT: Inspections are generally to be performed during each refueling outage at each reactor unit at a site. However, the level of ISI activities (including steam generator inspections) at each plant can vary significantly from outage to outage. Therefore, the inspection planning for each site should appropriately take into account these factors.

71111.08-01 INSPECTION OBJECTIVE

01.01 To assess the effectiveness of the licensee's program for monitoring degradation of the reactor coolant system boundary, risk-significant piping system boundaries, and the containment boundary.

71111.08-02 INSPECTION REQUIREMENTS

02.01 Scope. The scope of this inspectable area is limited to the following structures, systems, and components (SSCs):

a. Reactor coolant system pressure boundaries, including steam generator tubes in pressurized water reactors (PWRs).

b. Piping connected to the RCS, failure of which could result in an interfacing system loss of coolant accident.

c. Reactor vessel internals.

d. Risk-significant piping system boundaries.

e. Containment system boundaries (including coatings and post-tensioning systems, where applicable).

02.02 Inspection Activities Other Than Steam Generator Tube Inspections. The extent of licensee ISI activities may vary significantly from outage to

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outage. Therefore, it is at the region's discretion to determine whether to increase or decrease (or omit) the level of ISI inspections. If the decision is made to omit the inspection of ISI activities, the basis for this decision should be briefly documented. The degree to which the inspection activities listed below are completed are at the discretion of the regional staff and dependant on the level of ongoing ISI activities, as well as the level of effort expended on the steam generator inspection activities (Section 02.03).

a. Review a sample of nondestructive examination (NDE) activities. The review sample should consist of:

   1. Two or three types of NDE activities

   2. Order of preference for reviewed NDE activities:
      (a) Volumetric Examinations
      (b) Surface Examinations
      (c) Visual Examinations

b. For each NDE activity reviewed, perform the following through either direct observation (preferred method) or record review:

   1. Verify that the activities are performed in accordance with ASME Boiler and Pressure Vessel Code requirements.

   2. Verify that indications and defects, if present, are appropriately dispositioned.

c. Review one or two samples of rejectable indications/defects which have been accepted by the licensee for continued service. Verify that the licensee's acceptance for continued service was appropriate.

d. If welding on the pressure boundary for Class 1 or 2 systems has been completed since the beginning of the previous refueling outage, verify for 1-3 welds that the welding acceptance (e.g. radiography) and preservice examinations were performed in accordance with Code requirements. If no welding was performed, no action is required for this step.

e. Review one or two ASME Section XI Code repairs and replacements. Verify repairs and replacements meet Code requirements.

02.03 Steam Generator (SG) Tube Inspection Activities. The extent of SG inspection activities may vary significantly from outage to outage and from plant to plant. Therefore, it is at the region's discretion to determine whether to increase or decrease (or omit) the level of effort for steam generator inspections. If the decision is made to omit the inspection of steam generator activities, the basis for this decision should be briefly documented.

a. The inspector should attempt to schedule the inspection towards the end of the SG inspection activities because the licensee performs a significant

number of the inspection activities (listed below) at this time.

Attachment A lists specific situations which, if identified by the inspector, require notification of NRR/DE staff. This list may not be comprehensive and the inspector is encouraged to contact NRR/DE staff if a situation is encountered that is determined to be fairly unusual or unexpected based on the inspector's experience.

As a part of the preparation for SG tube inspections, the inspector should consider reviewing the licensee's commitments in response to Generic Letters (GLs) 95-03, 95-05, 97-05, and 97-06 (see References Section 05). In addition, the inspector should review the licensee's most recent SG inspection summary report. The inspector should also consider reviewing NRC generic communications, such as relevant information notices and regulatory information summaries. Lastly, the inspector should become familiar with the industry steam generator program guidelines contained in Nuclear Energy Institute (NEI) 97-06 and several related Electric Power Research Institute (EPRI) reports (see References Section 05).

If scheduled by NRR, the inspector should participate in the conference calls set up between NRC and licensee staff, during which steam generator tube examination activities are discussed. Significant issues that are discussed during the conference call should be considered for documentation in the inspection report. In addition, the inspector should review summaries from previous similar conference calls and can obtain these from NRR/DE staff.

b. Use the factors discussed below to determine the allocation of the inspection effort for review of the licensee SG inspection activities as described in step 02.03c. If any of the factors apply, this baseline inspection effort should include the inspection of SG activities. If more than one factor applies, or if the operating experience is more significant, then an increase in baseline SG inspection efforts should be considered. NRR/DE staff can be consulted for additional insights on this decision.

1. SGs with mill-annealed or stress relieved Inconel Alloy 600 tubes should receive a review as described in this section at least every other outage, or more frequently if other factors discussed below apply. For SGs with thermally-treated Inconel Alloy 600 and thermally-treated Alloy 690 tubes this review may not be required unless considerable inservice time (>9 yrs since beginning commercial operation and more than 2 operating cycles since the last NRC SG inspection) or other factors discussed below apply.

2. Deteriorating SG tube material condition as indicated by new degradation mechanism(s), or a large number or significant increase in the number of degraded or defective tubes reported by the licensee during the previous SG tube examinations. This information can be obtained from the licensee's most recent SG inspection summary report.

3. SG tube performance criteria (i.e., operational leakage, structural integrity, or accident leakage) were not met during the previous operating cycle.
4. PWRs with a history of primary-to-secondary leakage during the

previous operating cycle (e.g. > 3 gallons per day).

5. Reported potential degraded condition (e.g. NRC and industry information notices) due to SG design, water chemistry, material properties, or newly identified degradation mechanisms.

c. The following is a list of SG tube inspection activities. It is at the discretion of the inspector and regional management to determine the extent to which the activities are completed.

1. In-situ Pressure Testing

(a) Assess whether the in-situ screening criteria are in accordance with the EPRI Guidelines. In particular, assess whether assumed NDE flaw sizing accuracy is consistent with data from the EPRI examination technique specification sheet (ETSS).

(b) Assess whether the appropriate tubes are to be in-situ pressure tested (in terms of specific tubes and number of tubes).

(c) Observe in-situ pressure testing activities and assess whether tubes are in-situ pressure tested in accordance with EPRI In-Situ Pressure Test Guidelines.

(d) Review in-situ pressure test results for conformance with the performance criteria.

2. Compare the estimated size and number of tube flaws detected during the current outage against the previous outage operational assessment predictions to assess the licensee's prediction capability.

3. Confirm that the SG tube eddy current examination (ECT) scope and expansion criteria meet technical specification (TS) requirements, EPRI Guidelines, and NRC commitments.

4. If the licensee has identified a new degradation mechanism, ensure the licensee has considered the root cause and taken appropriate actions (e.g., additional inspections, in-situ pressure testing, preventive tube plugging, etc.).

5. Confirm that all areas of potential degradation (based on site-specific experience and industry experience) are being inspected, especially areas which are known to represent potential ECT challenges (e.g. top-of-tubesheet, tube support plates, U-bends).

6. Repair Criteria

(a) Confirm that the TS plugging limit (typically 40% through wall) is being adhered to, unless alternate tube repair techniques (e.g., sleeving or alternate repair criteria) have been approved by the NRC.

(b) Determine whether the depth sizing repair criterion (typically 40% through wall) is being applied for

indications other than wear or axial primary water stress corrosion cracking (PWSCC) in less than (<) 2 volt dents. (This may be acceptable per the licensee's TS, but NRR/DE staff is interested in these situations since experience has shown that many types of IGA/SCC cannot be sized with any degree of accuracy or reliability.)

7. If steam generator leakage was identified during operations or during post-shutdown visual inspections of the tubesheet face, assess whether the licensee has identified a reasonable cause for this leakage based on inspection results. In addition, determine whether appropriate corrective actions are planned or were taken.

8. Confirm that the ECT probes and equipment are qualified for the expected types of tube degradation. Assess the site specific qualification of several techniques.

9. If the licensee has identified loose parts or foreign material on the secondary side of the steam generator, focus on licensee corrective actions in conjunction with step 02.04 below. Specifically, confirm that the licensee has taken/planned appropriate repairs of affected SG tubes, inspected the secondary side of the SG to remove foreign objects (if possible). If the foreign objects are inaccessible, determine whether the licensee has performed an evaluation of the potential effects of object migration and/or tube fretting damage.

10. Review of "raw" eddy current data is typically not necessary in the context of this inspection. However, under certain emergent situations, this activity may be necessary. If adequate expertise for this activity does not reside in the regional office, NRR/DE should be contacted and can provide this resource.

02.04 Identification and Resolution of Problems. Verify that the licensee is identifying ISI/SG problems at an appropriate threshold and entering them in the corrective action program. Determine whether the licensee's procedures direct the licensee to perform a root cause evaluation and take corrective actions when appropriate. For a selected sample of problems associated with inservice inspection and steam generator inspection documented by the licensee, verify the appropriateness of the corrective actions. See Inspection Procedure 71152, "Identification and Resolution of Problems," for additional guidance.

71111.08-03 INSPECTION GUIDANCE

| Cornerstones | Inspection Objective | Risk Priority | Examples |
|---|---|---|---|
| Initiating Events<br><br>Mitigating Systems<br><br>Barrier Integrity | Verify the effectiveness of programs for monitoring the conditions of: 1) the RCS pressure boundary and containment barriers, 2) the boundaries of risk-significant components in auxiliary and ECCS piping systems | Reactor vessel<br><br>Steam generator tubes<br><br>Recirculation piping<br><br>ECCS connections to the RCS<br><br>Auxiliary feedwater system piping<br><br>Essential service water system piping<br><br>Other risk-significant piping components<br><br>Steel containment vessel<br><br>Post-tensioning systems and steel liner for Concrete containment<br><br>Shutdown and spent fuel cooling system pressure boundaries | Reactor vessel ultrasonic examination<br><br>Steam generator tube eddy current testing<br><br>Volumetric or surface examinations of risk-significant piping components<br><br>Inspection and testing of containment post-tensioning systems |

71111.08-04 RESOURCE ESTIMATE

This inspection procedure is estimated to take, on average, 32 hours for each Unit each refueling outage. An additional 32 hours per Unit, each refueling outage may be required for pressurized water reactor sites operating with older steam generators, based on an evaluation of the factors in step 02.03b above, particularly if non-steam generator inspection activities are performed in addition to the steam generator inspection activities. The extent of licensee inspection activities may vary significantly from outage to outage and from plant to plant. Therefore, it is at the region's discretion to determine whether to increase or decrease (or omit) the level of effort for the oversight of ISI activities and SG inspection activities.

This inspection should be performed by inservice inspection specialist(s).

ATTACHMENT A

## Tube Integrity Issues Requiring Further Evaluation by NRR Staff

If the following situations are identified by the inspector, NRR/Division of Engineering (DE) staff should be promptly contacted. NRR/DE staff will determine whether NRR involvement is necessary. This list may not be comprehensive and the inspector is encouraged to contact NRR/DE staff if a situation is encountered that is fairly unusual or unexpected based on the inspector's experience.

1. Selection of tubes to be in-situ pressure tested is not consistent with EPRI guidance (i.e., number of tubes to be tested, or specific tubes to be tested, or inappropriate treatment of NDE uncertainty).

2. In-situ pressure testing of flawed tubes is not successful in reaching the desired test pressure (e.g. main steam line break for accident induced leakage, 3 times normal operating differential pressure and 1.4 times main steam line break pressure for burst), either due to tube failure/leakage or equipment problems/limitations.

3. Estimated size or number of tube flaws detected during the current outage significantly conflicts with the previous outage operational assessment predictions.

4. Other than for wear, axial PWSCC in < 2 volt dents, and TS approved alternate repair criteria, tube degradation being sized for the purposes of determining whether the TS plugging limit (typically 40% through wall) has been exceeded and/or whether the tube is left in service. (This may be acceptable per the licensee's TS, but NRR/DE staff is interested in these situations since experience has shown that many types of IGA/SCC cannot be sized with any degree of accuracy or reliability.)

5. A tube repair criteria or repair process is being used which has not been reviewed by the NRC for use at this site (e.g. alternate tube repair criteria, or sleeving process).

6. Results of the tube inspection are not consistent with the amount of primary-to-secondary leakage observed during the previous operating cycle or during post-shutdown visual inspections of the tubesheet face.

71111.08-05 REFERENCES

ASME Boiler and Pressure Vessel Code Sections III, V, IX, and XI.

Plant-specific ISI program.

GL 95-03, "Circumferential Cracking of Steam generator Tube,"

GL 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking."

GL 97-05, "Steam Generator Tube Inspection Techniques."

GL 97-06, "Degradation of steam Generator Internals."

NEI 97-06, "Steam Generator Program Guidelines."

"PWR Steam Generator Examination Guidelines," EPRI Report TR-107569.

"Steam Generator Integrity Assessment Guidelines," EPRI Report TR-107621.

"Steam Generator In Situ Pressure Test Guidelines," EPRI Report TR-107620.

Inspection Procedure 71152, "Identification and Resolution of Problems."

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