INSPECTION PROCEDURE 50002

STEAM GENERATORS

PROGRAM APPLICABILITY: 2515

SALP FUNCTIONAL AREA: Maintenance (MAINT)

50002-01 INSPECTION OBJECTIVES

01.01 To ascertain the history and material condition of steam generator tubing including, when applicable, the type, magnitude, and location(s) of active degradation mechanisms.

01.02 To assess the effectiveness of licensee programs in detection and analysis of degraded tubing, repair of defects, and correction of conditions contributing to tube degradation.

01.03 To assess the effectiveness of licensee programs and training in regard to detection of and response to steam generator primary-to-secondary tube leakage.

50002-02 INSPECTION REQUIREMENTS

02.01 Steam Generator Fabrication and Degradation History

a. Determine the nuclear steam system supplier model number(s) for the installed steam generators.

b. Ascertain the number and size of tubes in the steam generators.

c. Determine the method(s) used and the length of expansion of tubes in the steam generator tubesheet(s).

d. Determine the number of tube supports that are present in the steam generators and applicable material type and hole configurations(s).

e. Ascertain the T_{Hot} value(s) that have been used by the licensee during commercial operation.

f. Determine the tube plugging/sleeving history for each steam generator, prior to and during operational service, and ascertain whether the licensee is collating eddy current

examination results with respect to the type, frequency and location of identified tube defects.

g. If metallurgical examinations of pulled tube samples have been performed, compare the defect type and size results against the corresponding non-destructive examination results.

h. Determine the limits of plugging/sleeving that are permitted by the accident analyses.

02.02 Tubing Materials. Ascertain the following from review of licensee and steam generator manufacturing records:

a. The technical and quality requirements specified by the manufacturer of the steam generator for procuring the steam generator tubing.

b. The conformance of a sample of the tubing vendor certified material test reports to the procurement requirements.

c. The type of annealing cycle used during manufacture of the steam generator tubing.

d. Whether any other thermal treatment was performed on the steam generator tubing:

1. By the tubing manufacturer.

2. During steam generator fabrication.

3. After installation of the steam generators.

If applicable, determine the specifics of the cycle performed and the number and location of thermally treated tubes.

e. Whether any actions have been taken to increase the resistance of the steam generator tubing to primary water stress corrosion cracking (e.g., shot peening of tubes in the expansion transition area, stress relief of low radius U-bends, etc.).

02.03 Tube Examination Program Requirements

a. General. Evaluate in detail the licensee's program requirements for eddy current examination of steam generator tubing. Include the following activities in the evaluation:

1. Review the current licensee/contractor eddy current examination procedures to ascertain whether they have been reviewed, approved, and issued in accordance with the licensee's QA program requirements.

2. Verify the conformance of the current program to the requirements of TS and the ASME Code.

3. Verify that all inspection techniques have been appropriately qualified for their intended use (i.e., detection, sizing).

4. Assess certification levels required for personnel involved in the acquisition, analysis and resolution of eddy current inspection data.

5. Determine whether the tube inspection sample size history conforms to TS requirements.

6. Verify that the eddy current examination program requirements contain provisions for assuring degraded tubes continue to be monitored in future inspections.

7. Assess the extent to which the licensee's present eddy current examination program conforms to industry guidelines, including a determination of whether the program achieves the following:

   (a) Provides eddy current data analysis guidelines which fully document relevant steam generator design features and plant-specific degradation history, and appropriately illustrate the analytical characteristics of known and potential degradation mechanisms.

   (b) Conforms to industry guidelines on sample size and sampling criteria.

   (c) Conforms to industry guidance on circumferential crack detection and length sizing.

   (d) Requires eddy current analysts to be trained and tested in accordance with the data analysis guidelines.

   (e) Includes a requirement for dual independent analyses of eddy current data, and a methodology for resolving differences in interpretation between the dual analyses.

   (f) Contains criteria for characterizing and dispositioning distorted or ambiguous bobbin coil indications.

   (g) Contains the capability to readily identify differences in calls between primary and secondary analysts.

   (i) Includes provisions for use of eddy current inspection techniques to:

      (1) Identify the presence of foreign objects lodged between abutting tubes.

      (2) Monitor for tube wear at these locations.

   (j) Includes provisions for use of eddy current methods for mapping the extent and height of sludge on the steam generator tube sheet.

(k) Establishes quantitative criteria for noisy data.

(l) Specifies a probe extension cable length and type that are consistent with the qualification process for each acquisition setup.

(m) Uses examination method(s), equipment, and practices that are consistent with the licensee's response to Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes."

(n) Requires use of calibration standards (for detecting circumferential cracking) which contain circumferential ID and OD electric discharge machined notches.

(o) Requires a periodic calibration of the probe delivery system (i.e., robotic arm) to ensure the fixture is locating the correct tube locations during the inspection.

8. Assess the adequacy of actions taken in response to NRC generic communications related to steam generators.

9. Ascertain whether program requirements contain:

(a) Provisions for tracking and collating individual data analyst performance.

(b) Feedback to data analysts on incorrect calls.

b. Plants with Alternate Repair Criteria at Tube Support Plates. For plants approved for alternate repair criteria, the inspector should review program requirements (and compare them against submittals to NRR) and determine the following:

1. Whether the program requires that a standard bobbin coil size be used (i.e., 0.720 inch for 7/8-inch tubes, 0.620 inch for 3/4-inch tubes) for examinations of intersections where the voltage-based limits are being applied. If alternate probe sizes are being used, ascertain whether NRR has approved the use of such probes.

2. Whether the licensee performs motorized rotating pancake coil (MRPC) examinations of all bobbin coil indications with voltages greater than 1.0 volt (3/4-inch tubes) and 2.0 volts (7/8-inch tubes), regardless of whether or not the tube will be plugged.

3. Whether the procedures specify the appropriate frequencies be used (e.g., 400/100 kHz mix for 7/8-inch tubes with a 0.050-inch wall thickness, 550/130 kHz mix for 3/4-inch tubes with a 0.043-inch wall thickness).

4. Whether site training for eddy current data analysts addresses the potential for primary-water stress

corrosion cracking (PWSCC) at tube support plate intersections.

5. Whether full-length bobbin coil examinations are required. If not, confirm that the licensee has performed full-length examinations on at least 20-percent of the tubes and is inspecting the remainder of the tubes down to the lowest support plate on the cold-leg side known to exhibit outside diameter stress corrosion cracking (ODSCC).

6. Whether the licensee performs MRPC examinations on all intersections with interfering signals from copper deposits, dents measured greater than 5 volts, and large mixed residuals.

02.04 Tube Examination Program Implementation

a. Observe activities for acquiring and analyzing eddy current data for a sample of tubes and confirm the following:

1. The applicable licensee work instructions specify the eddy current procedures to be used.

2. A copy of each procedure is available in the area in which the work is being performed.

3. Data acquisition is being performed using the probe(s), probe and extension cable length and type(s), and parameters specified by the examination procedure(s).

4. Fixture position verifications are being performed in accordance with procedural requirements.

5. Personnel performing eddy current data acquisition, analysis and resolution are certified to the appropriate levels (i.e., SNT-TC-1A certifications) as specified in the licensee's program requirements.

6. Eddy current data analysts have successfully completed applicable plant-specific training and testing.

7. Equipment setup and analysis of eddy current data conform to the requirements of the examination procedure(s) and the data analysis guidelines.

8. Program requirements for diagnosis and disposition of distorted or ambiguous bobbin coil indications are being implemented.

9. Dual analyses of eddy current data are being performed independently.

b. Observe the resolution process for a sample of tubes where dual analyses had resulted in different interpretations by the analysts, and confirm that the resolution process is being appropriately conducted.

c. Perform an independent examination of data from completed examinations of a sample of tubes. Examine, as a minimum, the following types of conditions:

1. Data for tubes where primary and secondary analysts have differed in interpretation.

2. Tube data showing distorted indications on initial bobbin coil examination. Determine in the review whether an appropriate approach was used to confirm the presence of a defect.

3. Tube data exhibiting degradation to which the analysts have assigned throughwall values close to the TS 40 percent repair limit.

02.05 Qualifications of Eddy Current Examination Personnel

a. Ascertain whether the qualification and certification records of contractor personnel performing eddy current examination data acquisition and analysis activities for the licensee contain the following:

1. Employer's name

2. Person certified

3. Activity qualified to perform

4. Level of certification

5. Effective period of certification

6. Signature of individual certifying title and level

7. Basis used for certification such as the required number of training hours

8. Annual visual acuity examination and periodic recertification

b. Ascertain whether personnel performing technical oversight of contractor eddy current examination activities for the licensee hold SNT-TC-1A eddy current certifications.

02.06 Foreign Material Exclusion. Determine whether the licensee is imple-menting appropriate foreign material exclusion controls for steam generator work activities. Include the following subjects in the evaluation:

a. Adequacy of control of tools, materials, and equipment that are used in the performance of examination, modification, repair, and replacement activities.

b. Practices used to minimize the ingress of foreign objects into the tube bundle, such as sealing the downcomer annulus during work in the upper steam generator areas.

c. Inspections at the conclusion of work activities to verify removal of all tools, equipment, and non-consumed materials.

02.07 Sludge Lancing. Review the sludge lancing history to determine whether the licensee has maintained an ongoing program for removing sludge from the steam generators. Review the following subjects:

a. The quantity of sludge that was removed in refueling outages by lancing the steam generator tube sheets.

b. Any actions taken to remove sludge from tube support interstices and the tube bundle.

c. Assessment of available sludge chemical composition data for possible contribution to tube degradation.

02.08 Water Chemistry History and Controls. Review the history and program requirements of the licensee's water chemistry program. Include the following subjects in the review:

a. Historical conformance of secondary water chemistry program with industry guidelines.

b. Historical conformance of primary water chemistry with TS limits.

c. Off-normal primary and secondary water chemistry history and actions taken to correct chemistry transients.

d. Water chemistry audit history.

e. Demineralizer resin control practices used to limit ingress of anions and cations into the demineralizer effluent.

f. Identification of any plant design features which create differences in secondary water chemistry between steam generators.

g. Capabilities and plans for on-line monitoring of water chemistry.

h. Capabilities and program requirements for detection and repair of condenser tube leaks.

i. Utilization of layup practices in refueling outages which minimize oxygenated conditions in the steam generators.

j. Adoption of industry initiatives such as molar ratio control, reduction of iron transport to the steam generators, use of alternative amines, and boric acid additions to the secondary side.

02.09 Primary-to-Secondary Leakage. Evaluate the effectiveness of licensee procedures, equipment, and practices for monitoring and responding to primary-to-secondary leakage. Include the following subjects in the evaluation:

a. Licensee responses to Bulletin 88-02 and Information Notices 88-99, 91-43, and 93-56.

b. Adequacy of procedures and equipment to provide real-time information on leak rate and its rate of change.

c. Appropriate setting of alarm setpoints on those radiation monitors that are used for detecting primary-to-secondary leakage (e.g. condenser air ejector, N-16) to alert operators to any increasing leak rate.

d. adequacy of emergency operating procedures and operator training for response to steam generator tube ruptures

02.10 Licensee Oversight of Steam Generator Activities

a. Evaluate the effectiveness of the licensee's controls over steam generator contractors. Determine to what extent licensee personnel are involved in assuring the quality of contractor-performed examination, repair, replacement, and cleaning activities.

b. Determine whether the licensee is performing appropriate oversight of contractor eddy current data acquisition and analysis personnel.

c. Verify that the licensee evaluates the conformance of identified tubing defects to the design margin requirements contained in its Regulatory Guide 1.121 structural integrity analysis.

50002-03 INSPECTION GUIDANCE

General Guidance

This inspection procedure has been written to support a comprehensive baseline evaluation of the material condition of steam generator tubing and the status of licensee steam generator degradation management initiatives. The inspection procedure may either be fully completed, if it is desired to establish a detailed understanding of licensee status, or, selectively implemented for inspections with more limited goals.

It is intended that the tubing examination items in this procedure be accomplished during either a refueling or mid-cycle outage. In general, most eddy current examinations of steam generator tubing are performed during refueling outages. Additional mid-cycle inspections are, however, being performed at certain plants where significant steam generators tubing degradation has been identified. To minimize regulatory impact, it is recommended, where possible, that the remaining procedural items be accomplished outside of an outage period.

Personnel performing the eddy current data analysis portion of this inspection need to be familiar with the methods, techniques, their applications, limitations, and the analysis of acquired data.

Specific Guidance

03.01 Steam Generator Fabrication and Degradation History

Background. The types of degradation that have necessitated plugging of steam generator tubing have changed over the past 20 years. Initially, the predominant degradation modes were tube wastage and denting. These problems have now largely been eliminated as active degradation mechanisms, as a result of a change from phosphate to all-volatile treatment of secondary water and the adoption of more comprehensive secondary water chemistry requirements. Intergranular stress corrosion cracking (IGSCC), intergranular attack, and fretting/wear have now emerged as the predominant degradation modes.

a-b. No specific inspection guidance provided.

c-d. Concentration of impurities in steam generator bulk water to aggressive levels is possible in occluded areas of the steam generator in which dryout occurs. Dryout and the resulting concentration of impurities can occur in tubesheet crevices (caused by variabilities in the expansion process or use of partial depth expansion techniques by the steam generator fabricator), tube support plate crevices, and sludge piles. Examples of design and fabrication practices that reduce occluded areas and the resultant dryout are the full depth expansion of the tube within the tubesheet, substituting quatrefoil or trefoil tube support plate hole configurations for drilled holes, and changing to ferritic stainless steel materials from carbon steels for tube support plates. The method used to expand tubes into a steam generator tube sheet can also affect the susceptibility to IGSCC, by determining the level and degree of variation of residual stresses that are present in the expanded and expansion transition region of the tubes. A significant incidence of IGSCC has occurred in these regions in tubes which were expanded by either mechanical rolling or explosive expansion methods. Operational experience, to date, indicates that a lower incidence of degradation has occurred in tubes expanded by a hydraulic method.

e. Studies show that temperature can significantly influence the rate of occurrence of primary water stress corrosion cracking (PWSCC) in Inconel 600 steam generator tubes. An Arrhenius relationship [failure time due to SCC $\propto e^{Q/RT}$, where Q is the apparent activation energy, R is the gas constant (0.001986 kcal/mole°K^{-1}), and T is the absolute temperature, °K] can be used to illustrate this effect. For example, the equation would suggest, for an assumed value of 50 kcal/mole for Q and the same materials and stresses, that the time for PWSCC occurrence would approximately double if T_{Hot} was decreased 18°F from 611°F to 593°F. Temperature may also contribute significantly to secondary-side IGSCC at tube sheet locations, due to the thermal insulation effects of sludge piles.

f-h. No specific inspection guidance provided.

03.02 Tubing Materials

a. This review may necessitate requesting the licensee to obtain the information from the nuclear steam system supplier.

b. No specific inspection guidance provided.

c-d. The susceptibility of Inconel 600 steam generator tubing to IGSCC is dependent, in part, upon the type of heat treatment that the tubing received. Tubing susceptibility to IGSCC for different heat treatment conditions is normally ranked, in order of decreasing susceptibility, as low temperature mill annealed, high temperature mill annealed, sensitized (i.e., receipt by annealed tubing of a second heat treatment cycle at 1100-1200°F during final post weld heat treatment of the completed steam generator), and thermally treated (i.e., heat treatment of the annealed tubing at approximately 1350°F). Low temperature mill annealed tubing was used in early Westinghouse steam generator models. Later models employed thermally treated tubing. High temperature mill annealed and sensitized tubing were used, respectively, in Combustion Engineering and Babcock and Wilcox steam generators. Thermally treated Inconel 690 tubing has typically been used for replacement steam generators because of its expected enhanced resistance to stress corrosion cracking.

e. Certain licensees have performed shot peening of the inside diameter of low temperature mill annealed tubing in the area of the tube sheet through the tube expansion transition region. This activity was performed to induce surface compressive stresses in the tubing and thus increase the resistance to PWSCC. Thermal stress reliefs have also been performed on low radius U-bends to increase the resistance of the bend region to stress corrosion cracking.

03.03 Tube Examination Program Requirements

a. General

1. No specific inspection guidance provided.

2. The TS state the current regulatory requirements for steam generator tubing inspection sample size and sample expansion criteria. Applicable ASME Code requirements for eddy current examination are defined in Section V, Appendix I, Article 8 and Section XI, Appendix IV. Because specific technical requirements vary among Code editions and addenda, the inspector should ensure that the requirements of the Code of record committed to by the licensee be used to verify the adequacy of the eddy current examination procedure.

3. Consistent with Appendix B to 10 CFR Part 50 regarding tube repair criteria, qualified techniques must be used

to quantify degradation in tubes being considered for a return to service; furthermore, the tube repair criteria must be explicitly stated in the technical specifications (e.g., a voltage combined with a signal-to-noise ratio approach should not be used unless authorized in the technical specifications). The technical specifications at most plants only contain depth-based tube repair criteria, and only a very limited number of degradation mechanisms can be reliably depth-sized. Qualified sizing techniques exist primarily for volumetric forms of degradation such as wear or wastage. Tubes with crack-like indications or other types of volumetric degradation (e.g., intergranular attack) that cannot be reliably depth- sized should be considered defective when dispositioning the tube and categorizing the inspection results. If a licensee is leaving tubes with such indications in service or relies on a technique for leaving tubes with such indications in service, the matter should be brought to the attention of NRR for further evaluation. This includes techniques that have met the qualification criteria contained in Appendix H of the Electric Power Research Institute (EPRI) Report NP-6201, "PWR Steam Generator Examination Guidelines: Revision 4," since the EPRI document may not provide acceptable guidance. [Reference: Letter from B.W. Sheron (Director, Division of Engineering) to J.T. Wiggins, A.F. Gibson, G.E. Grant, and T.P. Gwynn (Directors, Division of Reactor Safety), "Steam Generator Tube Repair Criteria," dated September 25, 1996]

4. Industry training and qualification criteria have been developed for nondestructive examination personnel performing eddy current data analysis of steam generator tubing, in order to promote a continuing uniform knowledge base and skill level for data analysts.

5-6. The licensee's technical specifications should include the minimum number of steam generators to be inspected, the scope of the inspection, and the expansion criteria to be applied on the basis of inspection results. The initial inspection scope should include all nonrepaired tubes that previously had detectable degradation; however, the industry has interpreted this to mean only degraded nonrepaired tubes in the steam generators selected for examination. Thus, it is possible that degraded nonrepaired tubes may not be reinspected for two or even three operating cycles. If the rotating inspection schedule does not appear sufficient for maintaining adequate tube integrity given the apparent indication and growth rate results from the current inspection, the matter should be brought to the attention of NRR. [Reference: Letter from J.R. Strosnider (Chief, Materials and Chemical Engineering Branch) to P.F. McKee (Director, Project Directorate I-3), "Alternating the Inspection of Steam Generators," dated October 3, 1996]

7. Comprehensive program guidance in regard to eddy current examination of steam generator tubing is provided to industry by EPRI NP-6201, "PWR Steam Generator Examination Guidelines." An inspector's review of a licensee's degree of implementation of EPRI NP-6201 criteria is of value in assessing of the overall effectiveness of licensee controls over contractors and the licensee's approach to managing steam generator tube degradation. The inspector should be aware, however, that conformance to EPRI NP-6201 is not a regulatory requirement. Industry guidance on the detection and sizing of circumferential cracking is given in an EPRI letter, "Points to Consider in Circumferential Crack Detection and Length Sizing," dated February 23, 1995.

8. Generic communications pertaining to steam generator tube examination, degradation, and repair issues are listed in 50002-05. The inspector should select a sample of these generic communications and assess the appropriateness of the licensee's evaluation and response.

9. No specific inspection guidance provided.

03.04 Tube Examination Program Implementation. Eddy current data acquisition practices and data analysis program activities can be appropriately evaluated by inspection personnel who have received only limited training in the eddy current examination method. Effective review of contractor data analysis performance and performance of independent data analysis will require, however, an appropriate level of knowledge of the eddy current examination method, hardware and software, and familiarity with the state of development and limitations of the method in regard to the examination of steam generator tubing.

03.05 Qualifications of Eddy Current Examination Personnel. Personnel involved in the performance of steam generator tubing eddy current data acquisition and analysis activities are expected to meet the qualification and certification requirements in the applicable supplement of SNT-TC-1A and ASME Code Section XI. Qualification certificates and the last annual visual acuity examination results are part of the nondestructive examination records. Holders of Level I certifications are restricted to data acquisition activities under the guidance of a Level II or III individual. Personnel performing data analysis are required to possess Level IIA or Level III certifications. Level III personnel are authorized to develop and approve examination procedures, as well as to administer training, examinations, and certifications, if specified.

03.06 Foreign Material Exclusion

No specific inspection guidance provided.

03.07 Sludge Lancing. The quantity of sludge removed and feedwater iron values provide a means of partially assessing the success of licensee secondary water chemistry initiatives in reducing corrosion product transport to the steam generators. A

significant percentage of iron in the feedwater comes from heater drains and extraction steam lines. Licensees have had some success in reducing feedwater iron from these sources by replacing ammonia for pH control with alternative amines. These amines are less volatile than ammonia and provide greater protection against flow-accelerated corrosion caused by wet steam.

03.08 Water Chemistry History and Controls. The TS provide quantitative primary water chemistry requirements and secondary water chemistry program criteria. Comprehensive secondary water chemistry program requirements are provided to industry by the EPRI "PWR Secondary Water Chemistry Guidelines." 50002-05 lists the different document numbers that were utilized for the successive revisions to these guidelines. Review by the inspector of the conformance to the guidelines during commercial operation is of value in assessing secondary side environmental history. The inspector should also take into account the time frame of operation of the plant with respect to the period of applicability of the guidelines (i.e., initial issue in October 1982), in that plants in operation prior to that date were subject to more limited secondary water chemistry requirements. The secondary water chemistry guidelines also serve as a useful reference because of the background information that is included with respect to degradation and secondary water chemistry initiatives. Additional inspection guidance is available to the inspector in Inspection Procedures 79501, "LWR Water Chemistry Control and Chemical Analysis - Audits," and 79502, "Plant Systems Affecting Plant Water Chemistry."

During the review of chemistry history and sludge removal information, the inspector should also consider whether copper alloys are present in the secondary side of the plant (e.g., condenser tubes and tube sheets, feedwater heater tubes, moisture separator reheater tubes). These alloys were selected for secondary side applications in some plants because of their generally good corrosion resistance. It is now believed, however, that copper can promote pitting and IGSCC in steam generator tubing. To minimize dissolution of secondary side copper alloys, and resulting transport to the steam generators, plants now restrict maximum feedwater pH. This restriction can increase the amount of iron transport to the steam generators compared with all ferrous secondary systems operated at a higher maximum pH value.

03.09 Primary-to-Secondary Leakage

a. No specific inspection guidance provided.

b-c. Comprehensive information on this subject appears in EPRI TR-104788, "PWR Primary to Secondary Leak Guidelines."

03.10 Licensee Oversight of Steam Generator Activities

a-b. No specific inspection guidance provided.

c. The inspector should ascertain whether the licensee has performed analyses to determine the limiting steam generator tubing defect size(s) with respect to the structural integrity requirements of Regulatory Guide 1.121. If

significant degradation is identified during eddy current examinations, the inspector should ascertain whether any defect potentially does not satisfy the design margin requirements of Regulatory Guide 1.121. Failure to satisfy the design margin requirements may affect the operating cycle length that can be justified between scheduled steam generator tubing examinations.

50002-04 RESOURCE ESTIMATE

Full performance of this inspection procedure is expected to take, on the average, 175 hours of direct inspection at a site.

50002-05 REFERENCE

Generic Communications

NRC Information Notice 96-38, "Results of Steam Generator Tube Examinations," June 21, 1996

NRC Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes," April 28, 1995

NRC Information Notice 94-88, "Inservice Inspection Deficiencies Result in Severely Degraded Steam Generator Tubes," December 23, 1994

NRC Information Notice 94-62, "Operational Experience on Steam Generator Tube Leaks and Tube Ruptures," August 30, 1994

NRC Information Notice 94-43, "Determination of Primary-to-Secondary Steam Generator Leak Rate," June 10, 1994

NRC Information Notice 94-05, "Potential Failure of Steam Generator Tubes Sleeved With Kinetically Welded Sleeves," January 19, 1994

NRC Information Notice 93-56, "Weaknesses in Emergency Operating Procedures Found as a Result of Steam Generator Tube Rupture," July 22, 1993

NRC Information Notice 93-52, "Draft NUREG-1477, 'Voltage-Based Interim Plugging Criteria for Steam Generator Tubes,'" July 14, 1993

NRC Information Notice 92-80, "Operation With Steam Generator Tubes Seriously Degraded," December 7, 1992

NRC Information Notice 91-67, "Problems With the Reliable Detection of Intergranular Attack (IGA) of Steam Generator Tubing," October 21, 1991

NRC Information Notice 91-43, "Recent Incidents Involving Rapid Increases in Primary-to-Secondary Leak Rate," July 5, 1991

NRC Information Notice 90-49, "Stress Corrosion Cracking in PWR Steam Generator Tubes," August 6, 1990

NRC Information Notice 89-65, "Potential for Stress Corrosion Cracking in Steam Generator Tube Plugs Supplied by Babcock and Wilcox," September 8, 1989

NRC Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs," May 15, 1989; Supplement 1 dated November 14, 1990; and Supplement 2 dated June 28,1991

NRC Information Notice 89-33, "Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs," March 23, 1989

NRC Information Notice 88-99, "Detection and Monitoring of Sudden and/or Rapidly Increasing Primary-to-Secondary Leakage," December 20, 1988

NRC Bulletin 88-02, "Rapidly Propagating Cracks in Steam Generator Tubes," February 5, 1988

Industry Documents

Note: The industry documents listed below, can be obtained from the region's library.

Letter from M. Behravesh (EPRI) to SGMP-1 Technical Advisory Group, et. al., "Points to Consider in Circumferential Crack Detection and Length Sizing," February 23, 1995.

EPRI NP-6201, "PWR Steam Generator Examination Guidelines," Revision 3

EPRI NP-2704-SR, "PWR Secondary Water Chemistry Guidelines," Revision 0

EPRI NP-5056-SR, "PWR Secondary Water Chemistry Guidelines," Revision 1

EPRI NP-6239, "PWR Secondary Water Chemistry Guidelines," Revision 2

EPRI TR-102134, "PWR Secondary Water Chemistry Guidelines," Revision 3

EPRI TR-104788, "PWR Primary to Secondary Leak Guidelines," dated May 1995

END