NEI 97-06 [Original]

Steam Generator Program Guidelines

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ACKNOWLEDGMENTS

The Nuclear Energy Institute (NEI) Task Force on Steam Generator Programs developed the *Steam Generator Program Guideline* with oversight provided by the NEI Steam Generator Issues Working Group. We appreciate those industry contributors who reviewed and commented on this document to improve its technical content and its clarity.

NEI also wishes to thank the Electric Power Research Institute (EPRI). EPRI, through the Steam Generator Strategic Management Project, developed the steam generator guidelines referenced in this document.

NOTICE

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Steam Generator Program Guidelines

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EXECUTIVE SUMMARY

NEI 97-06 establishes a framework for structuring and strengthening existing steam generator programs. Provided here are the fundamental elements expected to be included in a steam generator program. These elements incorporate a balance of prevention, inspection, evaluation, repair and leakage monitoring measures.

This guideline refers licensees to EPRI guidelines for the detailed development of these programmatic attributes. EPRI will maintain these guidelines through the Steam Generator Strategic Management Project (SGMP) consensus process. Revisions to the EPRI documents will follow the protocol as noted in Section 1.5 of this document. Other industry organizations, such as NSSS Owners Groups, may also develop guidelines for implementing steam generator program elements. Development and revision of referenced documents shall follow a protocol similar to the EPRI protocol.

The intent of this document is to bring consistency in application of industry guidelines relative to managing steam generator programs. This document and those it references recognize the need for flexibility within each plant-specific program to adjust for the degree of degradation experienced and expected improvements in techniques for managing tube degradation.

Section 1, "Introduction," provides a background, discusses regulatory interface, utility responsibilities, and protocol for revision of the referenced EPRI guidelines.

Section 2, "Performance Criteria," defines the performance criteria that utilities shall use to measure tube integrity. Meeting the performance criteria provides reasonable assurance that the steam generator tubing remains capable of fulfilling its intended safety function of maintaining RCPB integrity.

Section 3, "Steam Generator Program," discusses the program elements and implementing guidance for strengthening existing steam generator programs.

Section 4, "Reports to NRC," lists required reports.

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1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to bring consistency in application of industry guidelines related to managing steam generator programs. The framework offered in this document incorporates a balance of prevention, inspection, evaluation, repair and leakage monitoring measures. Additionally, this document establishes performance criteria that utilities shall use under the maintenance rule.

1.2 BACKGROUND

The program elements described in this document are evidence of the nuclear industry's commitment to safe and reliable steam generator operation. These elements focus on issues relative to the management and repair of steam generator tubing. For over two decades, the industry has expended considerable resources developing guidance on structuring steam generator programs to meet the challenges posed by continuing tube degradation.

Chemistry control is an example of the industry's commitment to the resolution and management of steam generator degradation. By the mid-1970s, utilities were plugging tubes at a rate that would exceed steam generator 40-year life design margins. The dominant damage form at that time was tube wastage. The industry corrected this by changing to an all-volatile water chemistry control. This, however, resulted in conditions conducive to corrosion of the carbon steel support plates, which led to tubing deformation as a result of denting and cracking with the same unacceptable rate of tube plugging. The industry, working through EPRI, met these challenges by implementing steam generator programs with aggressive improvements in control of secondary-side water chemistry and upgrades in secondary-side equipment, thus essentially eliminating both wastage and denting. The industry incorporated these successful programmatic strategies in the EPRI *Secondary Water Chemistry Guidelines* and associated supporting documents.

These chemistry guidelines have proven to be the cornerstones of the industry's effort to maintain acceptable steam generator performance. Over time, the industry's steam generator programs have matured to include improvements in programmatic features, such as non-destructive examination, primary-to-secondary leakage monitoring, and degradation-specific management. Building on the collective expertise of the industry, the EPRI Steam Generator Strategic Management Project (SGMP) oversees the maintenance of these guidelines, to incorporate technological and programmatic improvements.

1.3 UTILITY RESPONSIBILITIES

Each utility shall adopt the performance criteria contained in Section 2. The performance criteria are (1) Structural Integrity, (2) Accident-Induced Leakage and (3) Operational

Leakage. Further, each utility shall evaluate existing program elements against those described in Section 3 and revise and strengthen, where necessary, to meet the intent of this document and the referenced EPRI guidelines.

The steam generator program shall include the following elements:

- assessment of potential degradation mechanisms
- inspection
- integrity assessment
- maintenance and repairs
- primary-to-secondary leakage monitoring
- secondary-side water chemistry
- primary-side water chemistry
- foreign material exclusion
- maintenance of secondary-side integrity
- self assessment
- NRC reporting

Section 3 further discusses these program elements.

1.4 Regulatory Requirements

The following section addresses NRC requirements that licensees should include in the development and implementation of the plant-specific steam generator program.

1.4.1 10 CFR Part 50 Appendix A, *General Design Criteria for Nuclear Power Plants*, and Appendix B, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants*.

General Design Criteria (GDC) 1, 2, 4, 14, 30, 31 and 32 of 10 CFR Part 50, Appendix A, define requirements for the reactor coolant pressure boundary (RCPB) with respect to structural and leakage integrity. Steam generator tubing and tube repairs constitute a major fraction of the RCPB surface area. Steam generator tubing and associated repair techniques and components, such as plugs and sleeves, must be capable of maintaining reactor coolant inventory and pressure.

10 CFR 50, Appendix B, establishes quality assurance requirements for the design, construction and operation of safety-related components. The pertinent requirements of this appendix apply to all activities affecting the safety-related functions of these components: these include, in part, inspecting, testing, operating and maintaining. Criteria IX, XI, and XVI of Appendix B apply to the steam generator tube integrity program.

1.4.2 10 CFR § 50.65, *Maintenance Rule*

Under the maintenance rule, utilities classify steam generators as safety-related components because they are relied on to remain functional during and after design basis events. The performance criteria in Section 2 of this document shall be used to demonstrate that the condition of the steam generator "is being effectively controlled through the performance of appropriate preventive maintenance" (Maintenance Rule §(a)(2)). This guideline and the referenced EPRI guidelines define a steam generator program that provides the appropriate preventive maintenance that meets the intent of the maintenance rule.

Steam generators are to be monitored under §(a)(2) of the maintenance rule against industry-established performance criteria. If the performance criteria are not met, a cause determination of appropriate depth shall be done and the results evaluated to determine if goals should be established per §(a)(1) of the maintenance rule. Section 3.3, "Integrity Assessment," provides guidance for cause determination. Cause determination should identify the cause of the failure or unacceptable performance and whether the failure was a maintenance preventable functional failure. NUMARC 93-01 [Reference 1] offers guidance for implementing the maintenance rule should a utility elect to incorporate additional monitoring goals beyond the scope of this document.

1.4.3 10 CFR § 50.72, *Immediate Notification Requirements for Operating Nuclear Power Reactors*, and § 50.73, *Licensee Event Report System*

Failure to meet the performance criteria should be assessed to determine if it results in degradation of safety barriers. If so, the reporting requirements of §50.72 (b)(2)(i) and §50.73(a)(2)(i) or (ii) should be reviewed to determine applicability.

1.4.4 Plant Technical Specifications for Primary-to-Secondary Leakage

Plant technical specifications include a requirement to shut down when the plant exceeds an established threshold of primary-to-secondary leakage.

1.5 Preparation and Revision Protocol for EPRI Guidelines

Some of the EPRI guidelines referenced herein are directive in nature and the utility shall meet the intent of the guideline. Other EPRI guidelines are non-directive in nature and may be used by utilities as general guidance for structuring steam generator program elements. The protocol noted here applies to the directive EPRI guidelines.

At an interval not to exceed two years, the EPRI Nuclear Power Council (NPC) will convene a utility committee(s) to review the applicable EPRI guideline document to determine the need for revision.

Committee members include utility personnel, supplemented, as appropriate, by consultants, NSSS vendor and other supplier and/or service vendor personnel, all with equal voting rights. The members will have expertise relevant to the particular area being addressed. These committees are responsible to, and under the charter of, a utility sponsor group that broadly represents the management of the plants to which the prepared guidance is applicable. There will be an EPRI staff member on the committee, usually the chairperson, who will be a non-voting member. The NPC will approve the membership on the committees.

The directive guidelines referenced herein are:

- *PWR Steam Generator Examination Guidelines*, [Reference 2];
- *PWR Primary-to-Secondary Leak Guidelines*, [Reference 3];
- *PWR Secondary Water Chemistry Guidelines*, [Reference 4]; and
- *PWR Primary Water Chemistry Guidelines*, [Reference 5].

The requirements in the directive EPRI guidelines represent a consensus of the committee and are experience-based in that they are achievable with available technology. Requirements will be incorporated into the EPRI guideline documents when it has been successfully demonstrated that the requirement can be applied in operating plants.

Once the committee prepares a final draft, it is circulated for broad industry review. The committee then resolves all comments generated as a result of the review and prepares a final document to be approved and issued by the sponsor group.

The non-directive, how-to EPRI guidelines will be revised in a manner deemed appropriate by the committee originating the guideline. If at some point in time these documents become directive in nature, they will be handled via the formal committee approach described above.

The non-directive guidelines referenced herein are:

- *Steam Generator Tube Integrity Assessment Guidelines*, [Reference 6];
- *In-Situ Pressure Testing Guidelines*, [Reference 7];
- *PWR Steam Generator Tube Plug Assessment Document*, [Reference 8]; and
- *PWR Sleeving Assessment Document*, [Reference 9].

When a committee revises a directive EPRI guideline, utilities will modify their steam generator programs accordingly. Utilities should reflect program revisions in plant procedures for the upcoming refueling outage if that outage is greater than six months away. If the next refueling outage is less than six months away, the utility may delay incorporating appropriate changes until the following refueling outage.

2. PERFORMANCE CRITERIA

The steam generator performance criteria described below identify the standards against which performance is to be measured. Meeting the performance criteria provides reasonable assurance that the steam generator tubing remains capable of fulfilling its specific safety function of maintaining RCPB integrity.

Performance criteria used for steam generators shall be based on tube structural integrity, accident induced leakage, and operational leakage as defined below.

2.1 STRUCTURAL INTEGRITY PERFORMANCE CRITERION

The structural integrity performance criterion is to:

> ***Ensure steam generator tubes will maintain adequate margin against burst[1] under normal and postulated accident conditions for the operating cycle.***

The structural performance criterion is based on ensuring that there is reasonable assurance that a steam generator tube will not rupture during normal or postulated accident conditions. Section 3.3 of this guideline establishes the essential elements to meet this performance criterion.

The EPRI *Steam Generator Tube Integrity Assessment Guideline* [Reference 6] offers guidance for the evaluation methods, margin, and uncertainty considerations used to determine tube integrity. The non-probabilistic methods of Reference 6 include margins of safety against gross failure or rupture of the tubing. These margins are consistent with the safety factor margins implicit in the stress limit criteria of the American Society of Mechanical Engineers (ASME) Code.

The probabilistic method of Reference 6 is based on satisfying the conditional probabilities of induced tube rupture due to postulated accident loading conditions, including known and unknown degradation mechanisms. The conditional probability limits are:

- $<5 \times 10^{-2}$ per year that one tube ruptures during an accident,
- $<2.5 \times 10^{-2}$ per year that two to 10 tubes rupture during an accident, and

[1] A tube rupture or burst is a gross failure of the tube such that the formation of a primary-to-secondary opening with an area affiliated to that of a double-ended guillotine breakoccurs

- <1 x 10^{-3} per year that more than 10 tubes rupture during an accident.

The conservatism in these limits provides reasonable assurance for meeting the stated performance criterion.

2.2 Accident-Induced Leakage Performance Criterion

The accident-induced performance criterion is to:

> ***Ensure that the potential primary-to-secondary leak rate during limiting postulated events will:***
>
> - ***not exceed the total normal makeup capacity of the primary coolant system; and***
> - ***not exceed the offsite radiological dose consequences, per 10 CFR Part 100 guidelines, and the radiological consequences to control room personnel per GDC-19.***

The projected leakage of degraded steam generator tubes following an accident must not result in the associated radioactivity releases to the environment exceeding specified values. This criterion is specified in terms of dose to the maximum exposed individual offsite and dose to control room operators. Potential accident induced leakage is defined in a plant's licensing basis. Changes to the licensing basis require appropriate regulatory reviews.

As a defense-in-depth measure, a maximum leakage limit is additionally imposed in this performance criterion. The projected leakage must not exceed the normal reactor coolant system makeup capacity. As used in this document, *normal makeup capacity* refers to the ability of the makeup system to maintain reactor coolant system inventory without manual or automatic actuation of engineered safeguards features. Manual starting of redundant or standby pumps may be credited as normal makeup capacity if plant procedures provide for the additional pumps.

In lieu of calculating offsite and control room doses for each condition monitoring and operational assessment evaluation, utilities may determine a maximum allowable accident leakage limit based on plant-specific meteorology, dose-equivalent iodine limits, and iodine spiking considerations. This leakage limit would result in offsite and control room doses that meet the performance criterion and that are within normal makeup capacity. Once determined, the maximum allowable accident leakage would serve as a derived criterion against which the postulated accident induced leak rate would be compared.

2.3 Operational Leakage Performance Criterion

The operational leakage performance criterion is to:

> ***Ensure that the operational primary-to-secondary leakage limit for any one steam generator does not exceed 150 GPD.***

Plant technical specifications include a requirement to shut down within a prescribed time period when the plant exceeds an established threshold of primary-to-secondary leakage. The primary-to-secondary leakage limit referred to in the performance criterion is 150 gallons per day (GPD) at room temperature conditions from any one steam generator. In addition, since some types of tube degradation may propagate rapidly to rupture, plants should initiate shutdown when the leak rate increase exceeds 60 GPD over a one-hour period. This measurement should be confirmed using a qualitative method (e.g., steam generator blowdown radiation monitors, main steam line monitors, etc…).

3. STEAM GENERATOR PROGRAM

The purpose of a steam generator program is to ensure tube integrity. The program should contain a balance of prevention, inspection, evaluation and repair, and leakage monitoring measures. Licensees shall document the program through plant procedures. The major program elements are discussed below.

3.1 Assessment of Potential Degradation Mechanisms

Licensees shall perform an assessment of both existing and potential degradation mechanisms. The assessment shall address the reactor coolant pressure boundary within the steam generator, e.g., plugs, sleeves, tubes and the components that support the pressure boundary, such as secondary-side components. The assessment shall consider operating experience from other similar steam generators. The assessment shall also consider engineering analysis of the degradation mechanisms.

The purpose of the assessment is to identify degradation mechanisms and for each mechanism identified:

- choose techniques to test for that degradation based on the probability of detection and sizing capability;
- establish the number of tubes to be inspected;
- establish the structural limits; and
- establish the flaw growth rate.

The identification of these parameters allows a utility to establish the inspection or repair criterion before an outage. If a plant identifies a new degradation, or if the measured parameters change, such as growth rate, the plant may need to adjust analytical parameters during an inspection as the condition monitoring or operational assessment dictates.

The assessment of potential degradation mechanisms affects both the inspection and structural components of the program. The inspection component identifies the technique's capability, including detection probability, sizing capability, and measurement uncertainty. It will also identify the sampling strategy. The structural component applies the information gathered from the inspection with flaw growth rate projections to establish the repair limit and/or cycle length.

To conduct an effective inspection, the utility should integrate the structural and inspection components. EPRI *Steam Generator Tube Integrity Assessment Guidelines* [Reference 6] and EPRI *PWR Steam Generator Examination Guidelines* [Reference 2] provide guidance for assessment of potential degradation mechanisms.

3.2 Inspection

Each utility shall plan inspections according to the expected tube degradation and follow the inspection guidelines contained in the latest revision of the EPRI *PWR Steam Generator Examination Guidelines* [Reference 2].

Some of the important features include:

- sampling using either a prescriptive approach or a performance-based approach
- obtaining the information necessary to develop degradation assessments, e.g., condition monitoring and operational assessments
- qualifying the inspection program by determining the accuracy and defining the elements for enhancing system performance, including technique, analysis, field analysis feedback, human performance and process controls

3.3 Tube Integrity Assessment

Licensees shall assess tube integrity after each steam generator inspection. The purpose of the integrity assessment is to ensure that the performance criteria have been met for the previous operating period (e.g., condition monitoring), and will continue to be met for the next period (e.g., operational assessment). The EPRI *Steam Generator Tube Integrity Assessment Guideline* [Reference 6] offers guidance for the evaluation methods, margins, and uncertainty considerations used to determine tube integrity.

The choice of an evaluation method to verify tube integrity will depend on the uncertainty surrounding the particular degradation being assessed which can be highly dependent on the availability of data. Utilities may use activities such as in-situ pressure testing or pulling tubes to supplement the tube integrity analysis. Reference 6 provides guidance as to when to conduct in-situ pressure testing to address past operating period performance. The EPRI *In-Situ Pressure Testing Guidelines* [Reference 7] provide guidance on screening criteria for candidate tube selection, as well as for test methods and testing parameters.

If a licensee determines that the structural integrity or accident leakage performance criteria have not been satisfied during the prior operating period, an evaluation of causal factors for failing to meet the criteria shall be performed. In this event, the licensee is required to notify the NRC as discussed in Section 4

For an unscheduled inspection due to primary-to-secondary leakage, the tube integrity assessment need only address the degradation mechanism that caused the leak, provided the interval between scheduled inspections is not lengthened.

Licensees shall complete a tube integrity assessment for the next operating cycle within 90 days after startup. Completion of this assessment may not be possible due to the complexity of the analysis within the 90 day period. In this case, a preliminary assessment is acceptable as an interim measure. There should be reasonable assurance that the performance criteria will not be exceeded prior to completing and submitting the final assessment.

The completed assessment shall be submitted to the NRC within 12 months following the completion of the inservive inspection. Appendix D provides the content of this assessment report.

3.3.1 Repair Limits

Licensees shall establish tube repair limits for each active degradation mechanism. Tube repair criteria shall be either the existing technical specification through-wall (TW), depth-based criteria (i.e., 40% TW for most plants), a voltage-based repair limit per Generic Letter 95-05, or other alternative repair criteria (ARC). If licensees choose to develop and implement an ARC, they should follow a steam generator degradation-specific management (SGDSM) strategy. Reference 6 provides guidance for developing an ARC.

For plants experiencing a damage form or mechanism for which no depth sizing capability exists, tubes identified with such damage are "repaired/plugged-on-detection" and integrity should be assessed. Note: "Plug-on-detection" is not considered an ARC.

3.4 Maintenance and Repairs

Licensees shall qualify and implement repair methods in accordance with industry standards. The qualification of the repair techniques shall consider the specific steam generator conditions and mockup testing. The purpose of the repair is typically to remove degraded tubing from service, thereby redefining the reactor coolant pressure boundary.

Licensees shall clearly identify engineering prerequisites and plant conditions prior to performing the repair. Process controls shall be identified to ensure proper performance of the repair including the consideration of post maintenance testing. Additionally, licensees shall perform a baseline inspection of the repair consistent with the latest revision of the EPRI *PWR Steam Generator Examination Guidelines* [Reference 2].

The EPRI *PWR Steam Generator Tube Plug Assessment Document* [Reference 8] and the EPRI *PWR Sleeving Assessment Document* [Reference 9] provide further guidance for maintenance and repair of tubing.

3.5 Primary-to-Secondary Leakage Monitoring

Licensees shall establish primary-to-secondary leakage monitoring procedures in accordance with the EPRI *Primary-to-Secondary Leak Guidelines* [Reference 3]. Licensees shall initiate plant shutdown in a controlled and timely manner prior to exceeding 150 gallons per day (GPD) or when the leak rate increase exceeds 60 GPD in any one-hour period. This measurement should be confirmed using a qualitative method (e.g., steam generator blowdown radiation monitors, main steam line monitors, etc...).

Primary-to-secondary leakage monitoring is an important defense-in-depth measure that assists plant staff in monitoring overall tube integrity during operation. Monitoring gives operators information needed to safely respond to situations in which tube integrity becomes impaired and significant leakage or tube failure occurs. Additionally, operational leakage is an important tool for assessing the effectiveness of a steam generator program. Plants shall assess any operational leakage to determine if the leakage is expected or unexpected.

Appropriate training shall be provided for personnel who respond to primary-to-secondary leakage events.

3.6 Secondary-Side Water Chemistry

Each utility shall have procedures for monitoring and controlling secondary-side water chemistry to inhibit secondary-side corrosion-induced degradation in accordance with the EPRI *PWR Secondary Water Chemistry Guidelines* [Reference 4].

This program should establish, as a minimum:

- control parameters;
- a sampling schedule for the control parameters and action levels for these parameters;
- procedures used to measure the values of the control parameters;
- secondary sample points, including monitoring the discharge of the condensate pumps for evidence of condenser in-leakage;
- procedures for the recording and management of data;
- procedures for defining corrective actions for exceeding control parameter action levels; and
- procedures identifying the authority responsible for the interpretation of the data and the sequence and timing of administrative actions required to initiate corrective action.

3.7 PRIMARY-SIDE WATER CHEMISTRY

Each utility shall have procedures for monitoring and controlling primary-side water chemistry to inhibit primary-side corrosion-induced degradation in accordance with the EPRI *PWR Primary Water Chemistry Guidelines* [Reference 5].

This program should establish, as a minimum:

- control parameters;
- a sampling schedule for the control parameters and action levels for these parameters;
- procedures used to measure the values of the control parameters;
- primary sample points;
- procedures for the recording and management of data;
- procedures for defining corrective actions for exceeding control parameter action levels; and
- procedures identifying the authority responsible for the interpretation of the data and the sequence and timing of administrative actions required to initiate corrective action.

3.8 Foreign Material Exclusion

Each utility shall have procedures to monitor for loose parts and control of foreign objects to inhibit fretting and wear degradation of the tubing. This program should include the attributes below

3.8.1 Secondary-Side Visual Inspection

The program should define when such inspections are to be performed, the scope of inspection, and the inspection procedures and methodology to be used. Loose parts or foreign objects that are found should be removed from the steam generators, unless it is shown by evaluation that these objects will not cause unacceptable tube damage. This evaluation should be maintained as part of the inspection record. Tubes found to have visible damage should be inspected non-destructively and plugged or repaired if the repair criteria are exceeded.

3.8.2 Control and Monitoring of Foreign Objects and Loose Parts

The program should include procedures to preclude the introduction of foreign objects into either the primary or secondary side of the steam generator whenever it is opened (e.g., for inspections, repairs, and modifications).

Such procedures should include, as a minimum:

- detailed accountability for all tools and equipment used during an operation;
- appropriate controls and accountability for foreign objects such as eyeglasses and film badges;
- cleanliness requirements; and
- accountability for components and parts removed from the internals of major components (e.g., reassembly of cut and removed components).

Utilities should have alarm response procedures for the loose part monitoring system.

3.9 Maintenance of Steam Generator Secondary-Side Integrity

Secondary-side steam generator components shall be monitored if their failure could prevent the steam generator from fulfilling its intended safety-related function. The monitoring shall include design reviews, an assessment of potential degradation mechanisms, industry experience for applicability, and inspections, as necessary, to insure degradation of these components does not threaten tube structural and leakage integrity or the ability of the plant to achieve and maintain safe shutdown.

3.10 Self Assessment

Licensees shall perform self assessments regarding the steam generator management program. This review shall be performed by knowledgeable utility personnel or a contractor with independent experts selected by the utility on a periodic basis. An INPO assessment can be used as an adjunct to the self assessment. The self assessment should identify areas for program improvement, along with program strengths. The assessment shall include all of the essential program elements described in Section 3 above.

4. Reports to NRC

In addition to the utility-specific technical specification reporting requirements, the following reports are required:

Information to be reported	Report period
Failure to meet a performance criterion during tube integrity assessment	In acordance with time-frames specified in 10 CFR 50.72/73
The number of tubes plugged in each steam generator	15 days after completion of the inservice inspection
Information contained in Appendix D	12 months after completion of the inservice inspection

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APPENDIX A

References

1. NUMARC 93-01, *Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* (May 1993).

2. *PWR Steam Generator Examination Guidelines*, EPRI Report TR-107569 (Rev. 5, September 1997)

3. *PWR Primary-to-Secondary Leak Guidelines*. EPRI Report TR-104788 (Rev.0, June 1995)

4. *PWR Secondary Water Chemistry Guidelines*, EPRI Report TR-102134 (Rev. 4, December 1996)

5. *PWR Primary Water Chemistry Guidelines*, EPRI Report TR-105714 (Rev. 3, December 1995)

6. *Steam Generator Tube Integrity Assessment Guideline*, EPRI Report TR-107622, (Rev 0, September 1997)

7. *In-situ Pressure Testing Guidelines*. EPRI Report TR-107620 (Rev. 0, October 1997)

8. *PWR Steam Generator Tube Plug Assessment Document*, TR-10XXXX (Rev. 0, to be issued about December 1997)

9. *EPRI PWR Sleeving Assessment Document* TR-105962. (Rev 0. December 1995)

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APPENDIX B

List Of Definitions

The following definitions are provided to ensure a uniform understanding of terms used in this guideline.

Accident Induced Leakage

Primary-to-secondary leakage that occurs in a faulted steam generator as a result of a limiting accident.

Condition Monitoring

A comparison of the as-found inspection results against the performance criteria for structural integrity and accident leakage. Condition monitoring assessment is performed at the conclusion of each operating cycle.

Degradation-Specific Repair Criteria

Repair criteria developed for a specific degradation mechanism and/or location, e.g., a degradation specific repair criteria for ODSCC at tube support plates or for PWSCC at the tube sheet expansion.

Deterministic Approach

An approach that is based on the deterministic addition of parameter values to determine a limit.

Faulted

The state of the steam generator in which the secondary side has been depressurized due to a main steam line break such that protective system response such as main steam line isolation, reactor trip, safety injection, etc., has occurred.

Limiting Accident

An accident that results in the largest differential pressure across the steam generator tubes, normally a main steam line or main feedwater line break.

APPENDIX B (Cont'd)

Operational Assessment

Forward looking prediction of the steam generator tube conditions that is used to ensure that the structural integrity and accident leakage performance criteria will not be exceeded during the next cycle. The operational assessment needs to consider factors such as NDE uncertainty, indication growth, and degradation-specific repair limits.

Performance Criteria

Criteria to provide reasonable assurance that the steam generator tubing has adequate structural and leakage integrity such that it remains capable of sustaining the conditions of normal operation, including anticipated operational occurrences, design basis accidents, external events, and natural phenomena.

Probabilistic Approach

An approach that uses probabilistic simulations, e.g., Monte Carlo simulations, to determine appropriate limits.

Probability of Burst (POB)

The probability of burst of a steam generator tube if a limiting accident occurs.

Probability of Detection (POD)

The probability of detecting a flaw during a steam generator inspection.

Repair Limit

An NDE parameter value at which steam generator tube repair is required. The repair limit will be determined by either subtracting margins for NDE uncertainty and growth from the structural limit or by conducting a probabilistic analysis.

Normal Makeup Capacity

The ability of the makeup system to maintain reactor coolant system inventory without the manual or automatic actuation of engineered safeguards features, e.g., safety injection. Manual starting of redundant or standby pumps may be credited as normal makeup capacity if the additional pumps are provided for in plant procedures.

APPENDIX B (Cont'd)

Steam Generator Degradation-Specific Management (SGDSM)

The use of inspection and/or repair criteria developed for a specific degradation mechanism, e.g., outside diameter stress corrosion cracking at tube support plates.

Steam Generator Tube Rupture (SGTR)

A tube rupture or burst is a gross failure of the tube such that the formation of a primary-to-secondary opening with an area affiliated to that of a double-ended guillotine break occurs. For burst testing of limited length axial cracks, approximately two inches or less in length, the phenomenon requires extension of the crack tips. In most situations, extension of the degradation is necessary to achieve the level of opening needed.

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APPENDIX C

List of Acronyms

ARC	Alternative Repair Criteria
ASME	American Society of Mechanical Engineers
AVT	All Volatile Technology
CFR	Code of Federal Regulations
EOC	End of Cycle
EPRI	Electric Power Research Institute
GDC	General Design Criteria
GPD	Gallons Per Day
INPO	Institute of Nuclear Power Operations
ISI	Inservice Inspection
MSLB	Main Steam Line Break
MSLB-SGTR	Main Steam Line Break-Steam Generator Tube Rupture
NDE	Non-Destructive Examination
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
ODSCC	Outer Diameter Stress Corrosion Cracking
POB	Probability of Burst
POD	Probability of Detection
PWR	Pressurized Water Reactor

APPENDIX C (Cont'd)

PWSCC	Pressurized Water Stress Corrosion Cracking
RCPB	Reactor Coolant Pressure Boundary
SF	Safety Factors
SG	Steam Generator
SGDSM	Steam Generator Degradation Specific Management
SGMP	Steam Generator Management Project
SGTR	Steam Generator Tube Rupture
SL	Structural Limit
SLB	Steam Line Break
TR	Technical Report
TSP	Tube Support Plate

APPENDIX D

12 Month Report Content

1. Scope of inspections performed.
2. Active degradation mechanisms found.
3. NDE techniques utilized for each degradation mechanism.
4. Number of tubes plugged or repaired during the inspection outage for each active degradation mechanism. Repair methods utilized and the number of tubes repaired by each repair method.
5. Total number and percentage of tubes plugged and/or repaired to date and the effective plugging percentage in each steam generator.
6. Description of the tube integrity assessment.
7. Description of corrective actions implemented, if any.
8. Evaluation of circumstances if condition monitoring results exceeded the previous cycle operational assessment.