Steam Generator Management Program: Pressurized Water Reactor Steam Generator Examination Guidelines: Revision 7 Non-Proprietary Version of 1013706

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PRODUCT DESCRIPTION

This report provides requirements for examination plans and processes that are necessary to meet the performance criteria set forth in the Nuclear Energy Institute (NEI) 97-06, *Steam Generator Program*.

Results and Findings

This document continues to provide recommendations and requirements to the industry for sampling and inspection of steam generator (SG) tubing. The qualification for techniques and personnel is described in detail. Additionally, this document recognizes the improved performance of new SG tubing materials in the absence of foreign objects and in the presence of good chemistry controls. Data quality parameters continue to be an important attribute of an effective SG inspection. Inspection frequencies as described in Technical Specification Task Force (TSTF) report TSTF 449, *Steam Generator Tube Integrity,* are contained within this document. With these recommendations and requirements in place and implemented by the licensee, this document makes a significant contribution to meeting the requirements of NEI 97-06.

Challenges and Objectives

SG tubing, when degraded, can provide a challenge to the required safety functions in terms of structural stability and leakage. It is imperative that the condition of the SG be known so that appropriate repairs and operating parameters can be applied. Nondestructive examination (NDE) is the first step in determining the condition of the SG. This document is intended to be used by utility engineers, program managers, NDE personnel, and plant management in support of:

- Implementation of NEI 97-06
- Meeting the sampling and inspection requirements of TSF 449
- Technique and personnel qualification for input to condition monitoring and operational assessments

Applications, Value, and Use

The fundamental elements of NEI 97-06 represent a balance of prevention, inspection, evaluation, repair, and leakage monitoring measures. Implementation of these elements requires maintenance of this document to ensure applicability to the licensee for management of SG issues.

EPRI Perspective

NEI 97-06 requires condition monitoring and operational assessment of the SG tubing during and after an outage. These guidelines provide the recommendations and requirements for inspection, technique validation, data quality, and qualification of techniques and personnel.

This document reflects the current industry practices, with enhancements where the industry deemed necessary. Data management requirements were addressed for the first time in this document. The damage mechanisms in Appendix G were updated as a result of SG replacement projects. A new appendix on qualification of ultrasonic testing (UT) personnel was included to separate UT personnel qualification from Appendix G; Appendix J was separated from Appendix H for UT technique qualifications in the same manner. Appendix I was added to address the determination of NDE system uncertainties for tube integrity assessments (performance demonstration). The inspection frequencies, as described in TSTF 449, were included to ensure compliance with the licensee's technical specifications. The use of the terms "mandatory," "shall," and "recommend (should)" was addressed in accordance with the *EPRI Steam Generator Management Program Administrative Procedure, (*1011274). Additionally, the performance-based requirements previously contained in Section 4 have been deleted.

Since Revision 6 was published, interim guidance was issued four times:

- *Interim Guidance on Steam Generator Tube Leak at Comanche Peak Unit 1*, April 2003
- *Interim Guidance for Implementation of EPRI PWR Steam Generator Examination Guidelines: Revision 6*, April 2003
- *Interim Guidance for EPRI PWR Steam Generator Examination Guidelines: Revision 6, Section 6.3.3.3*, September 2003
- *Interim Guidance for EPRI PWR Steam Generator Examination Guidelines: Revision 6, Sections 6.2.4, 6.3.3.3, 6.5, and Appendix H supplements H1 and H2*, March 2004

This revision took into account the interim guidance documents issued since the last revision. Upon issuance of this document, all previous interim guidance is superseded.

Approach

An *ad hoc* utility committee under the direction of the NDE Issue Resolution Group (IRG) was convened to complete this revision. The main committee was organized with utility members chairing individual subcommittees for each report section and appendix. Each subcommittee contained participants from both utility and vendor organizations. The objective of this approach was to ensure that input was received from across the industry and that the most qualified personnel were available to work on the applicable sections. The subcommittees developed draft material to be reviewed by the main committee. Numerous teleconferences, web conferences, and meetings were conducted over an 18-month period to develop the final draft.

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Nuclear steam generators
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SGMP

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CONTENTS

1 INTRODUCTION AND BACKGROUND 1-1

1.1 Purpose 1-1

1.2 Scope 1-2

1.3 Background 1-2

2 COMPLIANCE RESPONSIBILITIES 2-1

2.1 Introduction 2-1

2.2 Management Responsibilities 2-1

2.3 Examination and Engineering Responsibilities 2-2

3 EXAMINATION REQUIREMENTS 3-1

3.1 Introduction 3-1

3.2 SG PSI Requirements 3-1

3.2.1 Inspection of Tubes 3-1

3.2.2 Inspection of Tube Sleeves 3-2

3.2.3 Inspection of Tube Plugs 3-2

3.2.4 Inspection of Other Tube Repairs 3-2

3.3 SG In-Service Inspection (ISI) Requirements 3-2

3.4 First ISI 3-4

3.4.1 First ISI of Tubes 3-4

3.4.2 First ISI of Sleeves 3-4

3.4.3 First ISI Examination of Plugs 3-4

3.4.4 First ISI of Other Tube Repairs 3-4

3.5 Subsequent ISIs 3-4

3.5.1 Subsequent Inspections of Tubing 3-4

3.5.2 Subsequent Inspection of Sleeves 3-5

3.5.3 Subsequent Inspection of Plugs 3-5

3.5.4 Subsequent Inspection of Other Repairs 3-5

3.6 Tube Examination Scope and Sampling Plans 3-5
3.7 Classification of Sample Plan Results 3-6
3.8 Expansion of the Examination 3-7
3.8.1 Expansion Requirements for Sample Plans 3-7
3.8.2 Expansion Requirements for Foreign Objects and Possible Loose Parts 3-7
3.9 Secondary Side Visual Examination 3-9
3.10 Forced Outage Guidance 3-9

4 SAMPLING REQUIREMENTS FOR PERFORMANCE-BASED EXAMINATIONS (DELETED) 4-1

5 STEAM GENERATOR ASSESSMENTS 5-1
5.1 Introduction 5-1

6 SYSTEM PERFORMANCE 6-1
6.1 Introduction 6-1
6.2 Technique Performance Requirements 6-1
6.2.1 Site-Validated Techniques 6-2
6.2.2 Diagnostic Techniques 6-2
6.2.3 Calibration Requirements 6-3
6.3 Analysis Performance Requirements 6-5
6.3.1 QDA 6-5
6.3.2 Site-Specific Performance Demonstration (SSPD) Requirements 6-5
6.3.3 Data Analysis 6-5
6.4 Data Management 6-11
6.4.1 Data Management Personnel Requirements 6-11
6.4.2 System Process Requirements 6-11
6.5 Data Quality Requirements 6-13
6.5.1 Probe Quality Parameters 6-16
6.6 Human Performance Requirements 6-17
6.7 Verification Responsibilities 6-18
6.8 Contractor Oversight 6-19
6.9 Requirements for Visual Inspection 6-19
6.9.1 Mechanical Plugs 6-19
6.9.2 Welded Plugs 6-19
6.10 Standardized Analysis Report Format 6-20

6.11 Standardized Raw Data Format 6-20

7 SUMMARY OF REQUIREMENTS 7-1

7.1 Introduction and Background 7-1

7.2 Compliance Responsibilities 7-1

7.3 Sampling Requirements for Prescriptive-Based Examinations 7-1

7.4 Sampling Requirements for Performance-Based Examinations 7-6

7.5 SG Assessments 7-6

7.6 System Performance 7-7

8 REFERENCES 8-1

A SAMPLING BASIS A-1

A.1 Sample Size A-1

A.1.1 Level of Confidence Relative to Sample Size and the Number of Tubes Affected by Degradation A-1

A.1.2 Statistical Basis for Level of Confidence A-2

B APPENDIX B-1

C APPENDIX C-1

D APPENDIX D-1

E APPENDIX E-1

F TERMINOLOGY F-1

F.1 Definitions F-1

F.2 Acronyms F-3

F.3 Three-Letter Codes F-6

G QUALIFICATION OF EDDY CURRENT EXAMINATION PERSONNEL FOR ANALYSIS OF EDDY CURRENT EXAMINATION DATA G-1

G.1 Scope G-1

G.2 Qualification Level G-1

G.2.1 General Requirements G-1

G.3 Written Practice G-2

G.3.1 General Requirements G-2

G.3.2 Responsibilities G-2
G.3.3 Use of an Outside Agency G-2
G.3.4 Transfer of QDA Qualifications G-2
G.3.5 Confidentiality G-3
G.3.6 Availability of Training Course Materials G-3
G.4 Qualification Requirements G-3
G.4.1 Training G-3
G.4.2 QDA Examinations G-4
G.4.3 SSPD Examinations G-11
G.5 Re-Grading QDA and SSPD Examinations G-12

_H_ PERFORMANCE DEMONSTRATION FOR EDDY CURRENT EXAMINATION H-1
H.1 Scope H-1
H.2 General Examination System Requirements H-1
H.2.1 Technique Requirements H-1
H.3 Performance Demonstration H-3
H.3.1 General H-3
H.3.2 Essential Variable Ranges H-3
H.3.3 Requalification H-3
H.3.4 Disqualification of Techniques H-4
H.4 Essential Variable Tolerances H-4
H.4.1 Instruments and Probes H-4
H.4.2 Computerized System Algorithms H-6
H.4.3 Calibration Methods H-6
H.5 Record of Qualification H-6
Supplement H1 Equipment Characterization H-7
H1.1 Scope H-7
H1.2 Eddy Current Instrument H-7
H1.2.1 Signal Generation H-7
H1.2.2 Amplification, Demodulation and Filtering H-8
H1.2.3 A/D Conversion H-10
H1.2.4 Channel Crosstalk H-11
H1.3 Probe Characterization H-12
H1.3.1 Impedance H-12
H1.3.2 Center Frequency H-12

H1.3.3 Coil Configuration Sensing Area H-12
Supplement H2 Qualification Requirements for Examination of SG Tubing H-19
H2.1 General H-19
H2.2 Qualification Data Set Requirements H-19
H2.2.1 General H-19
H2.2.2 Detection Data Set H-21
H2.2.3 Sizing Data Set H-21
H2.3 Acceptance Criteria H-22
H2.3.1 Detection Acceptance Criteria H-22
H2.3.2 Technique Sizing Performance H-24
Supplement H3 Protocol for PDD Revision H-25
H3.1 Scope H-25
H3.2 Administrative Responsibilities H-25
H3.2.1 New Techniques H-25
H3.2.2 Existing Techniques H-25
H3.3 Technique Originator Responsibilities H-25
H3.4 PDD Curator Responsibilities H-26
H3.5 PDD Peer Review Procedure H-26
H3.5.1 Team Structure H-26
H3.5.2 Conduct of the Review H-26
Supplement H4 Protocol for Technique Peer Review H-27
H4.1 Scope H-27
H4.2 Administrative Responsibilities H-27
H4.3 Technique Originator Responsibilities H-27
H4.4 Examination Technique Specification Sheet Curator Responsibilities H-27
H4.5 Peer Review Procedure H-27
H4.5.1 Team Structure H-27
H4.5.2 Conduct of the Review H-28

/ NDE SYSTEM MEASUREMENT UNCERTAINTIES FOR TUBE INTEGRITY ASSESSMENTS I-1

I.1 Scope I-1
I.2 Requirements I-1
I.2.1 General I-1
I.2.2 Personnel Requirements I-1

I.2.3 Technique Requirements I-1
I.3 Performance Demonstration I-2
I.3.1 Data Set Requirements I-2
I.3.2 Protocol I-2
I.3.3 Process Overview I-2
I.3.4 Acceptance Criteria I-2
I.3.5 Determining Noise-Dependent NDE System Performance I-3
I.4 Record of Qualification I-3
Supplement I1 ETSS Data Set Requirements I-4
I1.1 Data Acceptability Guidelines I-4
I1.2 Data Set Requirements I-4
Supplement I2 Performance Demonstration I-8
I2.1 General Requirements I-8
I2.2 Probability of Detection I-8
I2.3 Sizing I-8
Supplement I3 NDE System Performance Measures for Tube Integrity Assessments I-9
I3.1 NDE System Performance Measures I-9
I3.1.1 Probability of Detection I-9
I3.2.2 Sizing I-11
Supplement I4 Protocol for NDE System Peer Review I-13
I4.1 Scope I-13
I4.2 Administrative Responsibilities I-13
I4.3 Technique Originator Responsibilities I-13
I4.4 Curator Responsibilities I-13
I4.5 Peer Review Procedure I-13
I4.5.1 Team Structure I-13
I4.5.2 Conduct of the Review I-14

J PERFORMANCE DEMONSTRATION FOR ULTRASONIC EXAMINATION J-1
J.1 Scope J-1
J.2 Performance Demonstration J-1
J.2.1 General J-1
J.2.2 Essential Variable Ranges J-1
J.2.3 Requalification J-2

J.2.4 Disqualification of Techniques J-2
J.3 Essential Variable Tolerances J-2
J.3.1 Instruments and Search Units J-2
J.3.2 Computerized System Algorithms J-2
J.3.3 Calibration Methods J-3
J.4 Record of Qualification J-3
J.4.1 Examination Technique Specification Sheet J-3
Supplement J1 Equipment Characterization J-5
J1.1 Scope J-5
J1.2 Pulsers, Receivers, Search Unit, and Cable J-5
J1.2.1 Search Unit J-5
J1.2.2 Substituting a Pulser/Receiver or Ultrasonic Instrument J-8
J1.2.3 Cable J-8
J1.3 Documentation and Review of Changes J-9
Supplement J2 Qualification Requirements for Examination of SG Tubing J-10
J2.1 General J-10
J2.2 Qualification Data Set Requirements J-10
J2.2.1 General J-10
J2.2.2 Detection Data Set J-12
J2.2.3 Sizing Data Set J-12
J2.3 Acceptance Criteria J-13
J2.3.1 Detection Acceptance Criteria J-13
J2.3.2 Technique Sizing Performance J-15

K QUALIFICATION OF PERSONNEL FOR ANALYSIS OF ULTRASONIC EXAMINATION DATA K-1
K.1 Scope K-1
K.2 Responsibilities and Records K-1
K.3 Written Practice Requirements K-2
K.3.1 Training and Examination K-2
K.3.2 Responsibilities K-2
K.3.3 Use of an Outside Agency K-2
K.3.4 Transfer Qualifications K-2
K.3.5 Confidentiality K-2
K.3.6 Availability of Training Course Materials K-2

K.4 Qualification Requirements K-3
K.4.1 Training K-3
K.4.2 Written Examination K-3
K.4.3 Practical Examination K-4
K.5 Re-examination K-6
K.5.1 Written Examination K-7
K.5.2 Practical Examination K-7
K.6 Interrupted Service K-7
K.7 SSPD K-7
K.7.1 SSPD Training K-7
K.7.2 Written Examinations K-8
K.7.3 Practical Examination K-8
K.7.4 Retesting K-8

1
INTRODUCTION AND BACKGROUND

1.1 Purpose

This document is the seventh revision of the *PWR Steam Generator Examination Guidelines* [1], originally published in 1981 and revised in 1984, 1988, 1992, 1996, 1997, and 2002. The purpose of this document is to provide requirements and guidance for meeting the following objectives:

- Identification of degradation that effects SG tube integrity,
- Qualification of NDE systems used to detect and/or size degradation.

The requirements provided within this document promote accountability for the examination process, and provide for subsequent verification of compliance by internal or external audit. The protocol for deviating from specific requirements of this document is in the *EPRI Steam Generator Management Program Administrative Procedures* (SGMP) [2].

The requirements provided by this document assist in meeting the objectives of NEI 97-06, *Steam Generator Program Guidelines* [3]. NEI 97-06 brings consistency to the development and implementation of a program that monitors the condition of SG tubes against acceptable performance criteria in a manner sufficient to provide reasonable assurance that the SGs remain capable of fulfilling their intended safety function.

The *EPRI Steam Generator Management Program Administrative Procedures* [2] includes protocol that is to be followed by guideline revision committees with regard to establishing the level of implementation expected by a licensee. In particular, three categories or elements have been established: mandatory requirements, shall requirements, and recommendations. These categories are clearly defined in [2]. These categories are summarized below:

1. "Mandatory requirements ... are important to steam generator tube integrity and should not be deviated from by any licensee. Steam generator tube integrity is defined as meeting the performance criteria as specified in NEI 97-06 [3]".
2. "Shall requirements ... are important to long-term steam generator reliability but could be subject to legitimate deviations due to plant differences and special situations." Shall requirements appear throughout the document and are listed in Section 7.
3. "Recommendations are good or best practices that licensees should try to implement when practical. Written documentation is not required when a recommendation is not implemented." This document uses the term "should" interchangeably with the term "it is recommended".

1.2 Scope

1.3 Background

2
COMPLIANCE RESPONSIBILITIES

2.1 Introduction

The objective of this section is to identify organizational responsibilities necessary to ensure examination activities are effectively implemented for safe and reliable SG operation.

The Code of Federal Regulations, 10CFR50, Appendix B [7], requires each licensee to assume responsibility for those planned and systematic actions, such as inspection, necessary to provide adequate confidence that a structure, system, or component performs satisfactorily in service. Because the responsibility for SG examination resides with the licensee operating the unit, a consistently successful SG program requires the commitment of licensee management and a clear communication of that commitment to those responsible for the SG program. When the licensee contracts portions of the SG Program, the responsibility for program implementation and compliance with requirements always remains with the licensee. It is recommended that the authority and duties of persons and organizations planning and performing inspections be clearly established in written procedures and policies.

Although licensee organizational structures vary, there are common programmatic functions that are necessary to effectively implement the SG examination process. This section addresses the general role of those functions and is not intended to specify any particular organizational structure. It emphasizes the desirability of operating in a proactive rather than a reactive mode and the timely application of examination programs to enhance nuclear safety, reliability, longevity, and overall economic viability of SGs.

2.2 Management Responsibilities

Nuclear station management is responsible for providing sufficient resources and attention to the SG program. It is recommended that specific management responsibilities include the following:

- Ensure that areas of SG technical responsibility have been clearly assigned either to a single organization with coordination authority or to multiple organizations with an effective coordination and interface mechanism.
- Support establishment of appropriate levels of training in NDE and structural mechanics for SG engineers to enable them to evaluate inspection results associated with unusual conditions and assess their impact on tube integrity.

- Provide resources for NDE training and experience of selected licensee personnel with the goal of achieving formal Level III certification and Qualified Data Analyst (QDA) qualification.
- Ensure plant modification and configuration control programs have the flexibility to accommodate SG repair activities such as plugging, sleeving, and tube pulls.
- Provide independent and knowledgeable auditing organizations to periodically verify compliance with SG examination requirements.
- Designate a licensee individual, preferably a QDA, to be responsible for NDE within the SG program. This individual is knowledgeable in SG tubing NDE and provides ongoing, routine direction for the inspection element of the SG program. The expectation is reasonable continuity in this designation.

2.3 Examination and Engineering Responsibilities

The responsibilities of the SG examination and engineering function include planning, directing, and evaluating SG examination activities. This includes technical oversight of all contracted work associated with SG examinations and repairs. Engineering personnel provide a central control of SG examination activities and participate on the licensee's SG management committee to ensure integration of examination requirements. Examination and engineering responsibilities include the following:

- Maintain open communication with plant's NSSS engineering staff regarding potential degradation mechanisms.
- Ensure that each organization (for example, licensee or vendor) that conducts SG NDE inspections has a written program for conducting examinations.
- Develop eddy current examination specifications (detailed work scope) for inclusion in the bid package.
- Develop written guidelines and a documented plant-specific performance demonstration program for all data analysts.
- Prepare for supplemental examination methods and techniques to be utilized for indication resolution and characterization.
- Develop a plan to ensure that examination results are dispositioned in accordance with established criteria.
- Prepare for tube plugging, stabilization or repair, if applicable, including rerolling or sleeving.
- Ensure that tube repair methods have been thoroughly evaluated prior to generation of a repair list.
- Prepare for tube pulls and/or in situ pressure testing if condition monitoring or operational assessments so dictate.
- Establish and maintain a database management system to track inspection results and repairs.

- Maintain or have access to modification records, drawings, and the SG technical manual.
- Maintain management involvement by keeping them informed and seeking their endorsement.
- Communicate information with other responsible individuals involved with the plant's SG program.
- Following each examination, develop a final report that documents the results.
- Communicate examination results to other plants, vendors, and EPRI.
- Attend eddy current NDE training programs to enhance awareness of the significant aspects of examination techniques and processes.
- Prepare for supplemental examination methods and techniques to be utilized for tubes surrounding repairs that could damage in-service tubes.

3
EXAMINATION REQUIREMENTS

3.1 Introduction

3.2 SG PSI Requirements

3.2.1 Inspection of Tubes

3.2.2 Inspection of Tube Sleeves

3.2.3 Inspection of Tube Plugs

3.2.4 Inspection of Other Tube Repairs

3.3 SG In-Service Inspection (ISI) Requirements

3.4 First ISI

3.4.1 First ISI of Tubes

3.4.2 First ISI of Sleeves

3.4.3 First ISI Examination of Plugs

3.4.4 First ISI of Other Tube Repairs

3.5 Subsequent ISIs

3.5.1 Subsequent Inspections of Tubing

3.5.2 Subsequent Inspection of Sleeves

3.5.3 Subsequent Inspection of Plugs

3.5.4 Subsequent Inspection of Other Repairs

3.6 Tube Examination Scope and Sampling Plans

3.7 Classification of Sample Plan Results

3.8 Expansion of the Examination

3.8.1 Expansion Requirements for Sample Plans

3.8.2 Expansion Requirements for Foreign Objects and Possible Loose Parts

3.9 Secondary Side Visual Examination

Guidance for this topic has been relocated to the *EPRI Steam Generator Integrity Assessment Guidelines*.

3.10 Forced Outage Guidance

4
SAMPLING REQUIREMENTS FOR PERFORMANCE-BASED EXAMINATIONS (DELETED)

This section has been deleted.

5
STEAM GENERATOR ASSESSMENTS

5.1 Introduction

The following assessments are important elements of a written comprehensive SG program:

- Degradation Assessment
- Condition monitoring assessment
- Operational assessment
- Primary-to-secondary leakage assessment
- Self-assessment

Detailed requirements are provided in the EPRI *Steam Generator Integrity Assessment Guidelines* and the NEI 97-06 *Steam Generator Program Guidelines*.

6
SYSTEM PERFORMANCE

6.1 Introduction

This section provides requirements for technique performance, analysis performance, data management performance, data quality, human performance, verification, contractor oversight and visual inspection. In combination, they are referred to as system performance and each part adds value to ensure the tube examination results are useful in condition monitoring and operational assessments. Under field conditions, system performance is influenced by the capabilities of the process, procedures, examination equipment, techniques, and personnel. Ultimately, the licensee is responsible for the quality and accuracy of the inspection, providing oversight, review, and approval of all processes and procedures being used, work activities, and the integrity of the final results.

6.2 Technique Performance Requirements

6.2.1 Site-Validated Techniques

6.2.2 Diagnostic Techniques

6.2.3 Calibration Requirements

6.3 Analysis Performance Requirements

6.3.1 QDA

6.3.2 Site-Specific Performance Demonstration (SSPD) Requirements

6.3.3 Data Analysis

6.4 Data Management

Data management systems are used to manage the inspection, account for the examination scope, and provide accurate reporting of the results. The purpose of this section is to define the requirements for data management personnel and system process requirements.

6.4.1 Data Management Personnel Requirements

6.4.2 System Process Requirements

6.5 Data Quality Requirements

6.5.1 Probe Quality Parameters

6.6 Human Performance Requirements

6.7 Verification Responsibilities

6.8 Contractor Oversight

6.9 Requirements for Visual Inspection

6.9.1 Mechanical Plugs

6.9.2 Welded Plugs

6.10 Standardized Analysis Report Format

6.11 Standardized Raw Data Format

7
SUMMARY OF REQUIREMENTS

7.1 Introduction and Background

Requirement **Section**

7.2 Compliance Responsibilities

Requirement **Section**

7.3 Sampling Requirements for Prescriptive-Based Examinations

Requirement **Section**

7.4 Sampling Requirements for Performance-Based Examinations

Requirement	Section

7.5 SG Assessments

Requirement	Section

7.6 System Performance

Requirement	Section

6.9

8
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12. *Update on the Tools for Integrity Assessment Project*. EPRI, Palo Alto, CA: 2007. 1014756.
13. *User Manual – Crystal Ball® Monte Carlo POD Simulator*. EPRI, Palo Alto, CA: 2006. 1012988.
14. Technical Specification Task Force letter to the NRC (TSTF 05-05), dated April 14, 2005, TSTF-449, Revision 4, "Steam Generator Tube Integrity".

A
SAMPLING BASIS

A.1 Sample Size

The objective of conducting inspections of SG tubes is to monitor the condition of SG tubes against acceptable performance criteria in a manner sufficient to provide reasonable assurance that SGs remain capable of fulfilling their intended safety function. The purpose of examining samples of tubes rather than examining all tubes in SGs is to reduce the impact of meeting this objective. Consequently, the principal consideration in determining the appropriate sample size for tube examinations is the level of confidence that can be placed in the information obtained about the condition of SG tubes from examining a tube sample of given size.

A.1.1 Level of Confidence Relative to Sample Size and the Number of Tubes Affected by Degradation

A.1.2 Statistical Basis for Level of Confidence

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APPENDIX

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F
TERMINOLOGY

F.1 Definitions

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

Active Damage Mechanism

Historical term that is now synonymous with the term "existing" degradation that is found in the *EPRI Steam Generator Integrity Assessment Guidelines* [8].

Defective Tube

A tube that contains an indication that exceeds the repair limit.

Degradation

A reportable indication 20% TW or greater, or 50% of the repair limit for length-based or voltage-based criteria.

Degraded Tube

A tube with a reportable indication 20% TW or greater, or 50% of the repair limit for length-based or voltage-based criteria.

Dent

A local reduction (plastic deformation) in the tube diameter due to a buildup of corrosion products (magnetite).

Ding

A local reduction (plastic deformation) in the tube diameter caused by manufacturing, support plate shifting, vibration, or other mechanical means.

Essential Variables

The physical, mechanical, electrical, or chemical properties of the entire examination system which may vary or be varied and must be controlled or kept constant to ensure an expected examination response.

Extraneous Test Variables

Signal sources such as denting, deposits, support structures, geometry changes, and tubing essential variables that influence the test results.

Fatigue

Material failure resulting from the initiation and/or propagation of cracks due to cyclic loads.

Fill Factor

A measure of the degree to which a bobbin coil fills a tube. Specifically, the ratio of the square of bobbin coil OD to the square of the tube inner diameter.

Foreign Object (loose part)

Piece of material located within the SG where it does not belong. The material could have originated from outside of the SG or from within the SG and could be metallic or non-metallic.

Intergranular Attack

Corrosive attack of grain boundaries in materials with no preferential (stress-related) orientation.

Lane and Wedge Region

Tubes in a once-through SG associated with the untubed inspection lane.

Manufacturing Burnish Mark

A tubing condition where localized tubing imperfections were removed in the tubing mill or fabrication shop by buffing and are detectable due to the effects of cold working and localized wall thinning.

Permeability

Condition where the test coil impedance changes due to a change in the tubing material's inherent willingness to conduct magnetic flux lines.

Primary Water Stress-Corrosion Cracking (PWSCC)

SCC on the reactor coolant side (inside) of SG tubes.

Sludge

An accumulation of particulate matter found on the secondary side of the SG in low-flow areas.

Stress-Corrosion Cracking (SCC)

Intergranular cracking of tubes which is a result of complex interactions between stress, environment, and material.

Volumetric Wall Loss

The loss of tube material caused by general or localized thinning, wear, or IGA.

Wear

The loss of tube material caused by excessive rubbing of the tube against its support structure, a loose part, or another tube.

F.2 Acronyms

AAPDD	Automated Analysis Performance Demonstration Database
A/D	Analog-to-Digital
ALARA	As Low As Reasonably Achievable
ALC	Axial Length Coefficient
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
AVB	Anti-Vibration Bar
CFR	Code of Federal Regulations
CL	Confidence Level
dB	Decibel

DA	Degradation Assessment
DC	Depth Coefficient
DCSS	Direct Current Saturation Strength
DOV	Diametral Offset Value
ECT	Eddy Current Testing
EDM	Electro Discharge Machining
ESFW	Effective Scan Field Width
ETFW	Effective Track Field Width
ETSS	Examination Technique Specification Sheet
EPRI	Electric Power Research Institute
FFC	Fill Factor Coefficient
FOSAR	Foreign Object Search and Retrieval
Hz	Hertz
ID	Inside Diameter
IGA	Intergranular Attack
IGSCC	Intergranular Stress-corrosion Cracking
IQDA	Independent Qualified Data Analyst
IRG	Issue Resolution Group
ISI	In-Service Inspection
LOV	Lift-Off Value
NDD	No-detectable Degradation
NDE	Nondestructive Examination
NEI	Nuclear Energy Institute
NSSS	Nuclear Steam Supply System

OD	Outside Diameter
ODSCC	Outside Diameter Stress-Corrosion Cracking
ORNL	Oak Ridge National Laboratory
OTSG	Once-Through Steam Generator
PDC	Phase-to-Depth Curve
PDD	Performance Demonstration Database
PID	Positive Identification
PLP	Possible Loose Parts
POD	Probability of Detection
PSI	Pre-Service Inspection
PWR	Pressurized Water Reactor
PWSCC	Primary Water Stress-Corrosion Cracking
QDA	Qualified Data Analyst
r	Correlation Coefficient
RMSE	Root Mean Square Error
SCC	Stress-Corrosion Cracking
SDP	Standard Depth of Penetration
SG	Steam Generator
SGMP	Steam Generator Management Project
S/N	Signal-to-Noise
SSPD	Site-Specific Performance Demonstration
TAG	Technical Advisory Group
TSTF	Technical Specification Task Force
TT	Thermally Treated

TW	Through-Wall
TWC	Transverse Width Coefficient
UQDA	Ultrasonic Qualified Data Analyst
USNRC	United States Nuclear Regulatory Commission
UT	Ultrasonic Testing
VT-1	Visual Examination

F.3 Three-Letter Codes

The purpose of defining three-letter codes is to standardize their use in the industry. The use of Table F-1 codes on an industry-wide basis is recommended. A three-letter designation is used to describe eddy current inspection results. The codes are grouped into seven categories that describe actions required to assist in the correct disposition of the results. If new three letter codes are developed, then it is recommended that the user assign the applicable category.

CATEGORY I: No Further Action Required.

These codes represent a non-flaw tube condition.

CATEGORY II: Retest Required.

These codes represent a condition that requires retesting with the same or smaller diameter, magnetically biased or tuned frequency probe.

CATEGORY III: Supplemental Test Required.

These "I" codes represent (possible) flaw signals where no qualified sizing technique exists and require supplemental testing.

CATEGORY IV: Post-Supplemental Test Result.

These "S" codes are assigned when an indication previously reported as an "I" code receives a supplemental test that confirms a nonflaw condition or when a historical "S" code has been compared to a current signal and the signal has not changed.

CATEGORY V: Repair, ARC, or Engineering Evaluation Required.

These codes designate a repairable condition except when an approved alternate repair criteria is used.

CATEGORY VI: Repeat Repair May Be Required.

These codes designate incomplete repairs and may require rework depending upon the acceptance criteria.

CATEGORY VII: Review Indication, Review History, Supplemental Sampling, or Engineering Evaluation Required.

These codes require additional reviews (lead analyst or historical), additional diagnostic sampling, or engineering evaluations.

Table F-1
Three-Letter Codes

CATEGORY I: No Further Action Required	
Copper	CUD
Deposit	DEP
No Detectable Degradation	NDD
Plugged	PLG
Positive Identification	PID
Sleeved	SLV
Sludge	SLG
CATEGORY II: Retest Required	
Retest Analyst Discretion	RAD
Retest Bad Data	RBD
Retest Fixture	RFX
Retest Identification	RID
Retest Incomplete	RIC
Retest No Data	RND
Retest High Frequency	RHF
Retest Magnetically Biased	RMB
Retest Restricted Tube	RRT

Table F-1 (continued)
Three-Letter Codes

CATEGORY III: Supplemental Test Required	
Absolute Drift Indication	ADI
Differential Freespan Indication	DFI
Distorted Dent Indication	DDI
Distorted Expansion Indication	DEI
Distorted Support Indication	DSI
Distorted Tubesheet Indication	DTI
Loose Part With Indication of Tube Wall Degradation	LPI
Non-Quantifiable Indication	NQI
Plate Ligament Indication	PLI
CATEGORY IV: Post-Supplemental Test Result	
Absolute Drift Signal	ADS
Differential Freespan Signal	DFS
Distorted Dent Signal	DDS
Distorted Expansion Signal	DES
Distorted Support Signal	DSS
Distorted Tubesheet Signal	DTS
Loose Part Signal	LPS
No Degradation Found	NDF
Non-Quantifiable Signal	NQS
Plate Ligament Signal	PLS
CATEGORY V: Repair, ARC, or Engineering Evaluation Required	
Ligament Crack Indication	LCI
Mixed Mode Indication	MMI
Multiple Axial Indication	MAI
Multiple Circumferential Indication	MCI
Multiple Volumetric Indication	MVI
Obstructed	OBS

Table F-1 (continued)
Three-Letter Codes

CATEGORY V: Repair, ARC, or Engineering Evaluation Required (continued)	
Single Axial Indication	SAI
Single Circumferential Indication	SCI
Single Volumetric Indication	SVI
To Be Plugged	TBP
CATEGORY VI: Repeat Repair May Be Required	
No Heat Treatment	NHT
No Hydraulic Expansion	NHE
No Roll Expansion	NRE
No Support Expansion	NSE
No Weld Signal	NWS
CATEGORY VII: Review Indication, Review History, Supplemental Sampling, or Engineering Evaluation Required	
Bulge	BLG
Ding	DNG
Dent	DNT
Indication Not Found	INF
Indication Not Reportable	INR
ID Chatter	IDC
Lead Analyst Review	LAR
Lift-Off Signal	LOS
Manufacturing Burnish Mark	MBM
No Tubesheet Expansion	NTE
Noisy Tube	NSY
Over Expansion	OXP
Partial Tubesheet Expansion	PTE
Permeability Variation	PVN
Possible Loose Part without Indication of Tube Wall Degradation	PLP
Skip Rolled	SKR
Volumetric	VOL

G
QUALIFICATION OF EDDY CURRENT EXAMINATION PERSONNEL FOR ANALYSIS OF EDDY CURRENT EXAMINATION DATA

G.1 Scope

This appendix specifies personnel training and qualification requirements for eddy current examination personnel who analyze eddy current examination data for PWR SG tubing. Its purpose is to ensure a continuing uniform knowledge base and skill level for data analysts. The appropriate knowledge base is imparted using a comprehensive classroom and laboratory training program.

This appendix uses depth as a basis to establish flawed grading units based on the premise that repair criteria is expressed in terms of percent TW. Other NDE parameters, for example, amplitude can be substituted as grading units to demonstrate performance in accordance with this appendix when the applicable repair limit is expressed in terms of other NDE parameters. It is recommended that grading units be established over the full range of the parameter.

Analysts are qualified by successful completion of written and practical examinations defined in this appendix.

G.2 Qualification Level

G.2.1 General Requirements

G.3 Written Practice

G.3.1 General Requirements

G.3.2 Responsibilities

G.3.3 Use of an Outside Agency

G.3.4 Transfer of QDA Qualifications

G.3.5 Confidentiality

G.3.6 Availability of Training Course Materials

G.4 Qualification Requirements

G.4.1 Training

G.4.2 QDA Examinations

G.4.3 SSPD Examinations

G.5 Re-Grading QDA and SSPD Examinations

H
PERFORMANCE DEMONSTRATION FOR EDDY CURRENT EXAMINATION

H.1 Scope

a. This appendix provides performance demonstration requirements for eddy current examination techniques and equipment.

b. NDE technique qualification and documentation, including both destructive and NDE, shall be performed under 10CFR50 Appendix B Quality Assurance Program. Tubes pulled prior to April 15, 1999, may be excluded from 10CFR50 Appendix B requirements and may be grandfathered.

c. The performance demonstration requirements specified in this appendix apply to the acquisition process but do not apply to personnel involved in the data acquisition process. It is recommended that data acquisition personnel be trained and qualified by their employer in a manner commensurate with the tasks they perform. It is recommended that the requirements for training and qualification of such personnel be described in the employer's written practice.

d. Techniques that have been qualified in accordance with this appendix may be used in procedures without regard to the organization that qualified the technique.

e. All work associated with the NDE technique qualification, with the exception of the peer review, may be performed by competent technical personnel who are not QDAs.

H.2 General Examination System Requirements

H.2.1 Technique Requirements

H.3 Performance Demonstration

H.3.1 General

H.3.2 Essential Variable Ranges

H.3.3 Requalification

H.3.4 Disqualification of Techniques

H.4 Essential Variable Tolerances

H.4.1 Instruments and Probes

H.4.2 Computerized System Algorithms

H.4.3 Calibration Methods

H.5 Record of Qualification

Supplement H1
Equipment Characterization

H1.1 Scope

This supplement specifies essential variables associated with eddy current data acquisition instrumentation and establishes a protocol for essential variable measurement.

H1.2 Eddy Current Instrument

H1.2.1 Signal Generation

H1.2.2 Amplification, Demodulation and Filtering

H1.2.3 A/D Conversion

H1.2.4 Channel Crosstalk

H1.3 Probe Characterization

H1.3.1 Impedance

H1.3.2 Center Frequency

H1.3.3 Coil Configuration Sensing Area

Supplement H2
Qualification Requirements for Examination of SG Tubing

H2.1 General

H2.2 Qualification Data Set Requirements

H2.2.1 General

H2.2.2 Detection Data Set

H2.2.3 Sizing Data Set

H2.3 Acceptance Criteria

H2.3.1 Detection Acceptance Criteria

H2.3.2 Technique Sizing Performance

Supplement H3
Protocol for PDD Revision

H3.1 Scope

This supplement establishes the method to revise the Appendix G PDD. Revisions include additions/deletions of existing data, inclusion of new techniques or deletion of existing techniques.

H3.2 Administrative Responsibilities

H3.2.1 New Techniques

H3.2.2 Existing Techniques

H3.3 Technique Originator Responsibilities

H3.4 PDD Curator Responsibilities

H3.5 PDD Peer Review Procedure

H3.5.1 Team Structure

H3.5.2 Conduct of the Review

Supplement H4
Protocol for Technique Peer Review

H4.1 Scope

This supplement establishes the method and protocol for conducting industry peer reviews of Appendix H or J techniques. The peer review process is an independent review intended to provide oversight and verification of the qualification process.

H4.2 Administrative Responsibilities

H4.3 Technique Originator Responsibilities

H4.4 Examination Technique Specification Sheet Curator Responsibilities

H4.5 Peer Review Procedure

H4.5.1 Team Structure

H4.5.2 Conduct of the Review

I

NDE SYSTEM MEASUREMENT UNCERTAINTIES FOR TUBE INTEGRITY ASSESSMENTS

I.1 Scope

a. This appendix provides guidance for determining NDE system measurement uncertainties for tube integrity assessments.

b. Two NDE system performance measures are needed; 1) probability of detection (POD) and 2) sizing accuracy. Both performance measures are quantified using functional measures over the expected range of the structural variable.

c. NDE technique qualification and documentation, including both destructive and NDE, shall be performed under 10CFR50 Appendix B Quality Assurance Program. Tubes pulled prior to April 15, 1999, may be excluded from 10CFR50 Appendix B requirements and may be grandfathered.

I.2 Requirements

I.2.1 General

I.2.2 Personnel Requirements

I.2.3 Technique Requirements

I.3 Performance Demonstration

I.3.1 Data Set Requirements

I.3.2 Protocol

I.3.3 Process Overview

I.3.4 Acceptance Criteria

I.3.5 Determining Noise-Dependent NDE System Performance

I.4 Record of Qualification

Supplement I1
ETSS Data Set Requirements

I1.1 Data Acceptability Guidelines

I1.2 Data Set Requirements

Supplement I2
Performance Demonstration

I2.1 General Requirements

I2.2 Probability of Detection

I2.3 Sizing

Supplement I3
NDE System Performance Measures for Tube Integrity Assessments

I3.1 NDE System Performance Measures

I3.1.1 Probability of Detection

I3.2.2 Sizing

Supplement I4
Protocol for NDE System Peer Review

I4.1 Scope

This supplement establishes the method and protocol for conducting industry peer reviews of Appendix I techniques. The peer review process is an independent review performed by materials and/or tube integrity (MTI) engineers and QDAs. The intent of the peer review is to ensure that the tube degradation for an ETSS dataset properly represents that found in the field, and to provide oversight and verification of the qualification process. The peer review process is also an independent review of eddy current data acquisition and analysis techniques, and the destructive examination results to be applied for the performance demonstration.

I4.2 Administrative Responsibilities

I4.3 Technique Originator Responsibilities

I4.4 Curator Responsibilities

I4.5 Peer Review Procedure

I4.5.1 Team Structure

I4.5.2 Conduct of the Review

J
PERFORMANCE DEMONSTRATION FOR ULTRASONIC EXAMINATION

J.1 Scope

a. This appendix provides performance demonstration requirements for ultrasonic examination techniques and equipment for examination of SG tubing.

b. NDE technique qualification and documentation, including both destructive and NDE, shall be performed under 10CFR50 Appendix B Quality Assurance Program. Tubes pulled prior to April 15, 1999, may be excluded from 10CFR50 Appendix B requirements and may be grandfathered.

c. The performance demonstration requirements specified in this appendix apply to the acquisition process but do not apply to personnel involved in the data acquisition process. It is recommended that data acquisition personnel be trained and qualified by their employer in a manner commensurate with the tasks they perform. It is recommended that the requirements for training and qualification of such personnel be described in the employer's written practice.

d. Techniques that have been qualified in accordance with this appendix may be used in procedures without regard to the organization that qualified the technique.

e. All work associated with the NDE technique qualification, with the exception of the peer review, may be performed by competent technical personnel who are not qualified ultrasonic data analysts.

J.2 Performance Demonstration

J.2.1 General

J.2.2 Essential Variable Ranges

J.2.3 Requalification

J.2.4 Disqualification of Techniques

J.3 Essential Variable Tolerances

J.3.1 Instruments and Search Units

J.3.2 Computerized System Algorithms

J.3.3 Calibration Methods

J.4 Record of Qualification

J.4.1 Examination Technique Specification Sheet

Supplement J1
Equipment Characterization

J1.1 Scope

This supplement specifies essential variables associated with ultrasonic data acquisition instrumentation and establishes a protocol for essential variable measurement.

J1.2 Pulsers, Receivers, Search Unit, and Cable

J1.2.1 Search Unit

J1.2.2 Substituting a Pulser/Receiver or Ultrasonic Instrument

J1.2.3 Cable

J1.3 Documentation and Review of Changes

Supplement J2
Qualification Requirements for Examination of SG Tubing

J2.1 General

J2.2 Qualification Data Set Requirements

J2.2.1 General

J2.2.2 Detection Data Set

J2.2.3 Sizing Data Set

J2.3 Acceptance Criteria

J2.3.1 Detection Acceptance Criteria

J2.3.2 Technique Sizing Performance

K
QUALIFICATION OF PERSONNEL FOR ANALYSIS OF ULTRASONIC EXAMINATION DATA

K.1 Scope

This appendix specifies training and qualification requirements for personnel who analyze SG tubing ultrasonic examination data. Its purpose is to ensure a uniform knowledge base and skill level for ultrasonic data analysts. Analysts are qualified by successful completion of written and practical examinations as defined in this appendix.

An individual who successfully completes the requirements described herein is recognized as an Ultrasonic Qualified Data Analyst (UQDA). Note: The UQDA qualification can consist of detection only or detection and sizing in one or a combination of damage mechanism categories.

K.2 Responsibilities and Records

K.3 Written Practice Requirements

K.3.1 Training and Examination

K.3.2 Responsibilities

K.3.3 Use of an Outside Agency

K.3.4 Transfer Qualifications

K.3.5 Confidentiality

K.3.6 Availability of Training Course Materials

K.4 Qualification Requirements

K.4.1 Training

K.4.2 Written Examination

K.4.3 Practical Examination

K.5 Re-examination

K.5.1 Written Examination

K.5.2 Practical Examination

K.6 Interrupted Service

K.7 SSPD

K.7.1 SSPD Training

K.7.2 Written Examinations

K.7.3 Practical Examination

K.7.4 Retesting