NRC INSPECTION MANUAL

INSPECTION MANUAL CHAPTER 0327

STEAM GENERATOR TUBE PRIMARY-TO-SECONDARY LEAKAGE

Effective Date: 07/14/2023

0327-01 PURPOSE

To provide guidance to inspectors on overseeing pressurized water reactors (PWRs) with known steam generator (SG) tube primary-to-secondary leakage.

0327-02 OBJECTIVE

To assist inspectors in assessing licensee actions taken in response to SG tube primary-to-secondary leakage.

0327-03 APPLICABILITY

This manual chapter is applicable to any PWR with SG tube primary-to-secondary leakage.

0327-04 DEFINITIONS

There are no special definitions in this manual chapter.

0327-05 RESPONSIBILITIES AND AUTHORITIES

05.01 Director, Division of Reactor Oversight (DRO)

Establishes and monitors the execution of the inspection program feedback process.

05.02 Chief, Reactor Inspection Branch (IRIB)

Responsible for periodic updates to IMC 0327.

05.03 Chief, Corrosion and Steam Generator Branch (NCSG)

Responsible for the content of IMC 0327.

0327-06 REQUIREMENTS

There are no requirements in this document. This document is for guidance only.

0327-07 GUIDANCE

07.01 Background

While SG tubes often leak (i.e., experience ligament rupture of part through-wall degradation) before they burst (i.e., experience unstable failure) this is not always the case, and the possibility exists for burst with little or no observed leakage. For the cases where primary-to-secondary leakage can be detected, licensees have an opportunity to prevent tube burst by detecting primary-to-secondary leakage early and taking corrective action, such as plugging or sleeving. Routine leakage monitoring with adequate shutdown limits can afford early detection and response to increasing leakage and thereby serve as an effective means for reducing the probability of SG tube burst. Having near-real-time leakage information available to control room operators, along with appropriate alarm set points and corresponding action levels, can help operators promptly and appropriately respond to a developing situation.

07.02 Sources of Primary-to-Secondary Leakage

Primary-to-secondary leakage is ordinarily caused by degraded tubes, plugs, or sleeves. To determine possible sources of leakage, it is important to review what is known about the component materials and condition of the SG. Reviewing the licensee's latest SG Tube Inspection Report(s) should provide details regarding the condition of the SGs and the existing degradation mechanisms. Although operating experience may provide insights as to possible sources of degradation, sources of leakage cannot be reliably identified while the reactor is in operation. Therefore, leakage should be treated in accordance with available guidance.

Components fabricated from mill-annealed Alloy 600 (600MA) are highly susceptible to environmentally assisted degradation processes, such as outside diameter stress corrosion cracking (ODSCC) and primary water stress corrosion cracking (PWSCC). In plants with 600MA tubing, leakage is more likely due to an environmentally assisted corrosion process (e.g., ODSCC or PWSCC) or a repair process that exhibits some leakage (e.g., leak-limiting sleeves or plugs).

In contrast, mechanical degradation due to wear, fatigue cracks from vibration, and damage from loose parts are the most probable causes of leakage in plants with thermally treated Alloy 600 (600TT) and Alloy 690 (690TT) tubing, but these forms of degradation can also contribute to leakage in older plants with 600MA tubing. The operating experience with 600TT and 690TT components has been significantly better than the operating experience with Alloy 600MA, especially with regard to environmentally assisted degradation. To date, there has been only a limited amount of environmentally assisted degradation in 600TT components and there has been no known environmentally assisted degradation in 690TT components.

Cracking has been reported for some Westinghouse plugs manufactured out of Alloy 600TT. Industry experience with flawed plugs is discussed in NRC Information Notice (IN) 94-87, "Unanticipated Crack in a Particular Heat of Alloy 600 Used for Westinghouse Mechanical Plugs for Steam Generator Tubes," and NRC Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs," including two supplements. Most licensees have replaced the Alloy 600TT plugs with Alloy 690TT plugs. It is also possible to have flaws in the welds that are used to install tube sleeves, and some sleeve designs are leak-limiting rather than leak-tight.

07.03 Leakage Detection Methods

Most plants have radiation monitoring systems that monitor condenser off-gas, SG blowdown, and the main steam lines. The condenser off-gas is monitored to identify the presence of radioactive gases removed from steam condensate. The SG blowdown is monitored to identify non-volatile radioactive species in the SG bulk water (excluding once-through SGs). The main steam lines are monitored to detect volatile gases, and in some cases Nitrogen 16 (N-16), carried from the SGs via the main steam lines.

Grab samples are also commonly used, such as: reactor coolant samples (to quantify the source term), SG blowdown samples (to detect non-volatile radioactive species in liquid), and condenser off-gas samples (to detect noble gas and other volatile species removed from steam condensate). Other common grab samples include condensed main steam (to detect noble gas and other volatile species carried over with main steam) and condensate (to detect soluble species such as tritium and iodine). In addition, blowdown filters and ion exchanger columns are used to detect particulates and ionic species from liquid streams.

Although no single monitor should be expected to fulfill all monitoring roles, some monitoring methods have demonstrated particular value in certain situations. Continuous control room display of key radiation monitor trends (e.g., SG blowdown, condenser exhaust, N-16 monitor of leak rate and change in leak rate over time) gives operators real-time information that can be used to respond safely to the full range of primary-to-secondary leakage.

Use of N-16 monitors installed on or near steam lines has become increasingly common in the industry as a supplemental means of monitoring leakage. These monitors exhibit short time response to changes in leak rate and are very useful to operators, provided their limitations are understood. However, the short half-life for N-16 presents some problems in the ability of the detector to measure leak rate. Changes in power level and characteristics of the leak itself (location and type of leak) will affect the N-16 concentration reaching the detector. Once the reactor trips, N-16 quickly decays and no longer provides a radionuclide source for measuring leakage. Also, due to the high energy of the gamma rays emitted by N-16 decay, detectors may be affected by nearby steam lines in addition to the one they are mounted to. This can make it difficult to estimate total leakage or apportion leakage among the SGs based on N-16 alone.

It is prudent for the monitoring program to include provisions for detection of primary-to-secondary leakage during low power or plant shutdown conditions. This program should ensure that means are available to detect SG tube leakage whenever primary system pressure is greater than secondary system pressure, including hot shutdown and plant startup, when normal means of detecting leakage might be limited or unavailable. For instance, the radionuclide mix is altered following plant shutdown so condenser off-gas monitors may be questionable during startup, since they are calibrated for a specific radionuclide mix, based on power operation. In addition, N-16 monitoring is not considered reliable at low power since lower levels of N-16 are available to trigger detector response during a tube leak.

Plants spend a relatively small fraction of time in low power or hot shutdown conditions; however, it is prudent to have techniques and procedures available to detect a rapidly developing leak under those conditions. If a tube leak develops, operators should have reasonable time to respond to the situation before the plant reaches full power operation, when the consequences of a tube leak would be magnified.

The technical specifications include a limiting condition for operation limit with respect to the allowable primary-to-secondary leak rate, beyond which a prompt and controlled shutdown must be initiated. The limit is unit-specific, but it is no greater than 568 liters per day (150 gallons per day (gpd)) through any one SG.

Guidance to the industry is provided by the Electric Power Research Institute (EPRI) in "Steam Generator Management Program: PWR Primary-To-Secondary Leak Guidelines – Revision 5" (ADAMS Accession No. ML21060A803 – Proprietary). Detection capability and measurement uncertainties are discussed in the guidance, as well as the characteristics of certain monitoring methods. This is useful to licensees in determining the adequacy of specific parts of their monitoring system and the effectiveness of the combination of methods used.

07.04 Guidance from Industry SG Initiative

The industry currently relies on industry-developed guidelines to evaluate the significance of primary-to-secondary SG tube leakage. In the fall of 1997, the Nuclear Energy Institute's (NEI) Nuclear Strategic Issues Advisory Committee, a committee consisting of the chief nuclear officers from the nuclear utilities, voted to adopt NEI 97-06, "Steam Generator Program Guidelines." (Revision 3 – ML111310708). This commitment is in the form of an industry initiative and is an internal commitment between NEI members to take the agreed upon position. The industry informed the NRC by NEI letter dated December 16, 1997, of their commitment to implement the industry SG initiative described in NEI 97-06. Each licensee committed to evaluate its existing SG program and where necessary, revise and strengthen program attributes to meet the intent of the guidance provided in NEI 97-06, by no later than the first refueling outage starting after January 1, 1999.

In accordance with NEI 97-06, the SG management programs must address primary-to-secondary leak monitoring. Since adopting NEI 97-06, the industry has used the EPRI "Steam Generator Management Program: PWR Primary-To-Secondary Leak Guidelines" to assist in developing plant-specific procedures to manage small amounts of leakage within the context of their SG management program. The guidelines address management considerations, monitoring methods and equipment, leak rate calculations, operational response and data evaluation. The guidelines were developed in a manner consistent with industry's observed leakage experience and are intended to reduce the probability of tube ruptures under normal and faulted conditions.

The current version of the EPRI "Steam Generator Management Program: PWR Primary-To-Secondary Leak Guidelines – Revision 5" was implemented in December 2021. The guidelines direct the licensee to implement a monitoring program that accounts for plant design, SG tube degradation, and previous leakage experience. In addition, these guidelines recommend action levels defined by limits on the leak rate and the rate of change of the leak rate. The action levels provide a framework that licensees can use to formulate preplanned operator actions based on specified leakage indications. The objective for the normal operating leak rate limit or rate of change limit is to establish a reasonable likelihood that the plant is shut down before the tube could burst under either normal or faulted conditions. The operating leakage experience, together with the analytically based burst pressure versus normal operating leak rate trends, provide the bases for a recommended leakage limit.

07.05 Assessing the Significance of the Leakage

The EPRI “Steam Generator Management Program: PWR Primary-To-Secondary Leak Guidelines – Revision 5” use various operating conditions, leakage-assessment methodologies, radiation-monitoring conditions, and leakage-monitoring conditions, to assess the significance of SG primary-to-secondary leakage and direct appropriate actions. Specific conditions and actions are listed in section 3 of these guidelines, some of which are listed below.

Section 3.2.1 lists four operating conditions for which station-based actions are required, based on SG primary-to-secondary leakage:

- Modes 3 and 4: The period of operation during plant heatup or cooldown
- Mode 1 and 2 Non-Steady State: The period of operation during reactor startup, shutdown, or low power operations outside the site-specific definition of steady-state operation
- Steady State Power Operations: The Mode 1, steady-state plant condition, as defined in site-specific documents
- Power Transients: The period of operation with power transients outside the site-specific definition of steady-state operation that is not associated with startup

The specific operating modes listed above are defined by plant technical specifications or other regulatory guidance.

Section 3.2.2 lists two radiation monitoring conditions:

- Continuous Radiation Monitor: This condition is when there are one or more radiation monitors available, which meet the following requirements:
    - Continuous operation with an alarm function available in the Control Room, AND
    - The monitor is capable of detecting leakage of 30 gpd and higher, AND
    - The monitor output is correlated to gpd for continuous monitoring.
- No Available Continuous Radiation Monitor: This condition is when there are no continuous radiation monitors

Section 3.2.3 lists two leakage-monitoring conditions and three action levels, for plant actions based on observed primary-to-secondary leakage:

- Normal Monitoring: The condition in which detected leakage is less than 5 gpd
- Increased Monitoring: The condition in which leakage has been detected but is not in a range that can be accurately monitored by most online radiation monitors, does not necessarily indicate imminent risk to steam generator tube integrity, but warrants additional attention

- Action Level 1: The plant condition in which leakage has increased to a condition that requires frequent monitoring by the radiation monitoring system with periodic benchmarking by laboratory analyses

- Action Level 2: The plant condition in which leakage has increased to a condition indicating that the underlying flaw has grown to an undesirably large size and it is mandatory that the unit be shut down in a planned manner

- Action Level 3: The plant condition, which indicates that the leakage is increasing rapidly and it is mandatory that the unit be promptly shut down to protect the unit from tube rupture

Section 3.3 lists two leakage-assessment methodologies that can be used to respond to primary-to-secondary leakage during power operation:

- Constant Leakage: Under the constant leakage methodology, site-specific procedures and expectations are developed, which ensure Action Levels are implemented based only on leakage rate

- Rate of Change: Under the rate of change methodology, site-specific procedures and expectations are developed, which ensure Action Levels are implemented based on an evaluation of the leakage rate and the rate of change in leakage

There are many possible actions that licensees are directed to take in response to SG primary-to-secondary leakage; see the EPRI "Steam Generator Management Program: PWR Primary-To-Secondary Leak Guidelines – Revision 5" for specific recommended actions based on specific plant conditions.

Based on historical operating experience, it is suggested that the NRC resident inspectors and regional staff use an informal screening criteria of 3 gpd or greater for increased involvement by NRC headquarters staff when SG primary-to-secondary leakage is identified. This is not meant to be an absolute threshold, because there may be instances where something unusual about the leakage, or other conditions, warrant the region wanting headquarters staff involvement before leakage reaches 3 gpd. If a licensee reports levels of primary-to-secondary leakage exceeding 3 gpd to the resident inspector or regional staff, the Division of Operating Reactor Licensing (DORL) in the Office of Nuclear Reactor Regulation (NRR) should be informed. The DORL project manager will inform the Corrosion and Steam Generator Branch (NCSG) staff.

Key items the NCSG staff are concerned about include:

1. The rate of change of the leakage, to assess how quickly the situation is changing

2. Whether the leakage rate has been confirmed by two independent radiation monitors (i.e., trend in the same direction with the same order of magnitude)

3. Whether the licensee's primary-to-secondary leak monitoring program has a well-documented set of policies and procedures that are being used to respond to the leakage event

4. Whether there is any plant history that provides insight into the cause of the primary-to-secondary leak

When leakage exceeds 3 gpd, parameters that inspectors can consider in assessing the significance of the leakage are the effectiveness of licensee procedures, equipment, and practices for monitoring and responding to primary-to-secondary leakage. For example, the adequacy of procedures and equipment, to provide real-time information on leak rate and its rate of change, could be assessed. The appropriate setting of alarm set points on the radiation monitors that are used for detecting primary-to-secondary leakage (e.g., condenser air ejector, N-16) to alert operators of any increasing leak rate could be assessed. In addition, the adequacy of emergency operating procedures, availability of systems and components, and operator training for response to SG tube ruptures could also be assessed. Inspection activities associated with primary-to-secondary leakage are found in IP 71111.08, "Inservice Inspection Activities." In addition, the inspector may use IP 71111.24, "Testing and Maintenance of Equipment Important to Risk," to verify licensee's surveillance activities, IP 71111.04, "Equipment Alignment," to conduct any plant walk downs, and IP 71111.15, "Operability Determinations and Functionality Assessments," to review any operational or technical decision-making activities and to pursue any operability concerns.

Note: The NRR staff occasionally receives notification of extremely low levels of leakage (e.g., <1 gpd). These levels of leakage don't typically need to result in increased interaction of NRR staff with the licensee. This is because many plants have experienced this level of leakage during a full cycle, and it is difficult to determine the source of the leakage at that level. Often, small levels of leakage will persist for the rest of the operating cycle for some plants. While these small levels of leakage do not require increased interaction by NRR staff, the licensee still needs to evaluate and attempt to determine the source of the leakage.

The following section discusses some of the typical questions that inspectors can pursue with the licensee when leakage is reported. The NCSG staff is available if further support is needed.

07.06 Questions to Gain Additional Information about the Leakage

Questions should focus on how the licensee is monitoring the leakage, evaluating the potential sources of leakage, and what the past inspection results and in-situ testing information tell them about the condition of their SGs.

It is useful for the inspector to understand how the licensee detected the leakage, and what the leakage history for this unit (and the specific SG) was for previous outages. There are various advantages and disadvantages of various monitoring techniques, which can affect the quantity of leakage reported.

After shutdown, the licensee may observe evidence of leakage from post-shutdown visual inspections of the tubesheet face. Additional information may be available from secondary-side leak tests performed early during outages to identify leaking tubes. To conduct these tests, nitrogen pressure is applied to the water inventory in the secondary side of the SGs and maintained for an extended period (often for days). If the visual inspections reveal any observed dampness or drops of water from the tubesheet face, tubes in that area need to be evaluated carefully with appropriate inspection methods.

Sometimes plants experience very low levels of leakage with no clear cause identified. Small changes in low levels of leakage can be due to changes in monitoring equipment, either putting new equipment in service or recent calibrations of the existing equipment.

In the past, the staff was informed of small changes of observed leakage that directly correlated to putting new detection equipment in service. This led to a step increase in the very small amount of leakage observed. This could also be observed after calibrating equipment, or any other major change that would reset the baseline readings.

The inspector should recognize that although reliable identification of the leakage source is not possible while the plant is operating, insights might be obtained by discussing with the licensee the SG tube examination findings from the eddy current testing during the last outage, in-situ pressure test results, and the licensee's knowledge of loose parts in the SGs.

The inspector can ascertain information on the degradation modes being experienced by the SGs. For example, tube wear from anti-vibration bars (AVB) can have a significant through-wall extent, even in replaced SGs that have not been in service many years. Plants have qualified sizing techniques for AVB wear, so indications of wear are sometimes left in service for the next operating cycle.

For any reported active degradation modes, the inspector can ask the licensee about in-situ pressure test results from previous outages. If the licensee had trouble satisfying the performance criteria of the in-situ pressure test, it may indicate that the flaws were deeper than sized by the SG eddy current tests.

Some plants also have known loose parts in the affected SG that they have not been able to retrieve, which they have identified through techniques such as FOSAR (foreign object search and retrieval). In some cases, the licensees will plug tubes around a loose part that they are unable to retrieve, to reduce the chance of tube rupture from the loose part during the next cycle.

It should also be noted that it is not practical for licensees to shut down plants at low levels of leakage. In fact, sustained leakage below 10 gpd in some older plants with 600MA tubing is not unusual. As noted above, when plants shut down, leakage tests are used to identify leaking tubes. Some plants that shut down with low leakage levels found it very difficult to determine the source of the leakage. Accordingly, the staff's ability to influence the actions of licensees with low levels of known primary-to-secondary leakage is limited.

In summary, obtaining background information about operating and inspection experience may provide useful insights regarding the significance of ongoing primary-to-secondary leakage. Because reliable identification of the leakage source is difficult while the plant is operating, the NRC staff's primary role should be to ensure that the licensee is responding to leakage in a conservative manner by monitoring the leakage and being prepared to implement plant shutdown, consistent with EPRI guidelines.

0327-08 NRC GENERIC COMMUNICATIONS AND REGULATORY GUIDANCE

a. USNRC IN 94-87: "Unanticipated Crack in a Particular Heat of Alloy 600 Used for Westinghouse Mechanical Plugs for Steam Generator Tubes," (December 1994)

b. USNRC IN 94-43: "Determination of Primary-to-Secondary Steam Generator Leak Rate," (June 1994)

c. USNRC IN 91-43: “Recent Incidents Involving Rapid Increases in Primary-to-Secondary Leak Rate,” (July 1991)

d. USNRC Bulletin 89-01, “Failure of Westinghouse Steam Generator Tube Mechanical Plugs,” (May 1989)

e. USNRC Regulatory Guide 1.97, “Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident,” (December 1980)

f. USNRC Regulatory Guide 1.45, “Reactor Coolant Pressure Boundary Leakage Detection Systems,” (May 1973)

Table 1 provides a summary of forced outages from 1990 to 2014, due to SG tube leaks. References to NRC documents that contain more information about the events are provided for many of the events listed in table 1.

Table 1: Tube Leak Forced Outages at US PWRs

Plant Name (Tube Material)	Date	Leak Rate (gpd)	Cause	Reference
St. Lucie 1 (600MA)	Jan. 1990	3	Foreign Object	
TMI 1 (600MA)	Mar. 1990	1440	Fatigue	NRC IN 91-43
Millstone 2 (600MA)	May 1990		Cracked Plug	
North Anna 2 (600MA)	Aug 1990	40	Cracked Plug	
Oconee 2 (600MA)	Nov. 1990	130	Fatigue	
Shearon Harris (600MA)	Nov. 1990	50	Loose Part	
Maine Yankee (600MA)	Dec. 1990	1440	PWSCC	NRC IN 91-43
San Onofre 1 (600MA)	Apr. 1991	150	Sleeve Joint	Event Notification (EN) 20860
Millstone 2 (600MA)	Apr. 1991	70	U-bend SCC	Preliminary Notification (PN) 1-91-030

Plant Name (Tube Material)	Date	Leak Rate (gpd)	Cause	Reference
Millstone 2 (600MA)	May 1991	70	Tubesheet Circumferential Crack	EN 21077
McGuire 1 (600MA)	Jan. 1992	250	Freespan Crack	PN 2-91-002 NRC IN 94-62
ANO 2 (600MA)	Mar. 1992	360	Tubesheet Circumferential Crack	PNs 4-92-018, 081A, EN 22975 NRC INs 92-80 & 94-62
Prairie Island 1 (600MA)	Mar. 1992	144	Roll Transition Zone Axial Crack	
McGuire 1 (600MA)	May 1992	5	Stress Corrosion Cracking	Morning Report (MR) 3-92-0255, PN 23400
Prairie Island 1 (600MA)	Sep. 1992	187	Likely Inter-granular stress corrosion cracking (IGSCC)	MR 3-92-0255, PN 3-92-048
McGuire 1 (600MA)	Nov. 1992	250		
Trojan (600MA)	Nov. 1992	200	Sleeve Weld Circumferential Crack	PN 5-92-035, EN 24569
Palo Verde 2 (600MA)	Mar. 1993	240	Upper Bundle Freespan IGSCC	PN 5-93-009, -009A, -009B, 009C, -009D, EN 25255, NRC INs 93-56, 94-43 & 94-62
Kewaunee (600MA)	Jun. 1993	100	Leaking Plug	MR 3-93-0167
McGuire 1 (600MA)	Aug. 1993	185 - 200	Sleeve Failure	PN 2-93-038, EN 25990, NRC INs 94-05 & 94-43
Palo Verde 3 (600MA)	Sept 1993		Freespan crack	MR 5-93-0066, PN 5-93-017
McGuire 1 (600MA)	Oct 1993	185	Circumferential crack in sleeved tube	PN 2-93-053

Plant Name (Tube Material)	Date	Leak Rate (gpd)	Cause	Reference
Braidwood 1 (600MA)	Oct. 1993	300	Freespan Cracks	PN 3-93-061, NRC Information Notice 94-62
San Onofre 3 (600MA)	Nov. 1993	50	Loose parts degradation and leaking welded plugs	MR 5-93-0081, PN 5-93-020
Farley 2 (600MA)	Nov. 1993			MR 2-93-0132 Licensee Event Report (LER) 364/1993-003
McGuire 1 (600MA)	Jan. 1994	100	Leaking Sleeve	PN 2-94-003, EN 26665
Oconee 3 (600MA)	Mar. 1994	144	Fatigue	PN 2-94-014, EN 26967
S. Texas 1 (600MA)	Mar. 1994	160	Leaking Plug	PN 4-94-005A, EN 26859
Zion 2 (600MA)	Mar. 1994	1440	Tubesheet Crevice Inter Granular Attack Outside Diameter	EN 26901
Oconee 2 (600MA)	Jul. 1994	144	Fatigue	PN 2-94040
Maine Yankee (600MA)	Jul. 1994	50	Circumferential Crack PWSCC	MR 1-94-0079, EN 27587, NRC IN 94-88
Zion 1 (600MA)	Feb. 1996		Foreign object	PN 3-96-009
Byron 2 (600TT)	Aug. 1996	120	Loose Part	PN 3-96-049, MR 3-96-0106
Vogtle 1 (600TT)	May 1996		Foreign object	PN 2-96-041, EN 30555
ANO 2 (600MA)	Nov. 1996	65	Axial Crack	PN 4-96-061, EN 31344
McGuire 2 (600MA)	June 1997	66	ODSCC at TSP	PN 2-97-033

Plant Name (Tube Material)	Date	Leak Rate (gpd)	Cause	Reference
Oconee 1 (600MA)	Nov. 1997	400	2 Welded Plugs	PN 2-97-065, -065A, EN 33458
Farley 1 (600MA)	Dec. 1998	90	2 Freespan Cracks	LER 3481998007
Indian Point 2 (600MA)	Feb. 2000	210, 240 146 gallons per minute	U-bend Crack	EN36695, NRC IN 2000-09
Byron 2 (600TT)	June 2002	80	Loose Part	NRC IN 2004-10
Comanche Peak 1 (600MA)	Sep 2002	52	Axial ODSCC Crack in the U-bend	NRC IN 2003-05
Palo Verde 2 (690TT)	Feb 2004	11	Fabrication Damage (Packaging Screw)	PN IV-4-007, NRC IN 2004-16
Harris (690TT)	May 2004	10	Loose Part	NRC IN 2004-17
Arkansas Nuclear One 2 (690TT)	Mar 2005	30	Loose Part	NUREG-1841
San Onofre 3 (690TT)	Jan 2012	>75 gpd	Tube-to-tube Wear	PN IV-12-003 Augmented Inspection Team Report (ML12188A748)
HB Robinson 2 (600TT)	Mar 2014	38	Loose Part	PN II-14-004, NUREG-2188
Salem 1 (600TT)	Feb 2020	47	Loose Part	Integrated Inspection Report 50272/2020002 ML20219A654

END

Attachment 1: Revision History for IMC 0327

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-decisional, Non-public Information)
	10/11/2001	Initial issuance as TG 9900 “Steam Generator Tube Primary-to-Secondary Leakage”		
	ML032661079 09/09/2003 CN 03-033	Revision to remove inspector actions for leakage greater than 3 gallons per day. The inspector actions have been moved to IP 71111.08, Inservice Inspection Activities. Section 9900 is only for inspector guidance.		
	ML18093B067 11/01/18 CN 18-037	TG9900 “Steam Generator Tube Primary-to-Secondary Leakage” converted to IMC 0327. References to the “EPRI PWR Primary-To-Secondary Leak Guidelines” within this document were revised from Revision 2 to Revision 4. Extensive changes were made to this document, because of the multiple revisions that had occurred to the referenced EPRI guidelines. As this is a technical guidance document, there are no inspection requirements contained within it and this was noted in the “Requirements” section of the document.	None	ML18094A274 9900-2273 ML18109A204
	ML23193A962 07/14/23 CN 23-020	Minor changes to reflect organizational changes in divisions within NRR and a new revision to an EPRI guideline. Table 1 was updated with a new forced outage event from 2020.	None Required	n/a