SGMP Responses to NRC RIS 2000-22 and NRC Lessons Learned Report

The following document contains the SGMP responses and NRC comments on NRC Steam Generator Action Plan items (reference NRC memo on SG Action Plan, Nov 2000[1]). The document contains the following information for each item:

- The item identification - consists of a number that ties the item to the NRC documents written after the IP2 tube leak. The key to the numbering system is contained in the NRC's SG Action Plan[1] (LL=NRC IP2 Lessons Learned Task Force Report[2], RIS = RIS 00-22[3]).
- A verbatim quote of the action plan item
- The initial industry response to the item ("boxed" in section) with the date that the response was submitted to the staff.
- The staff's summary of the industry's response
- The staff's evaluation of the industry's response.
- The industry's reply to the staff's comments, entitled "Additional Industry Comments (8/9/02)"

1 NRC Internal Memo (B Sheron to S Collins), "*Steam Generator Action Plan*", dated November 16, 2000
2 "*Indian Point 2 Lessons Learned Task Force Report*" (TAC No. MA9163), dated October 23, 2000
3 NRC Regulatory Issue Summary 2000-22, "*Issues Stemming from NRC Staff Review of Recent Difficulties Experienced in Maintaining Steam Generator Tube Integrity*, dated November 3, 2000"

Issue 1 from RIS 2000-22:

Consideration of relevant operating experience and appropriate diagnostic, corrective, or compensatory measures to ensure tube integrity.

Issue 2 from RIS 2000-22:

Assessment of the root causes of all degradation mechanisms at a plant and appropriate diagnostic, corrective, or compensatory measures to ensure tube integrity.

Initial Industry Response (4/26/01)

RIS-1: Consideration of Relevant Operating Experience

Adequate industry guidance has been issued to address this issue.

Issue 1 is NRC's concern that IP2 did not consider industry experience in a degradation assessment. The failure mechanism that led to the IP 2 tube failure was essentially the same mechanism that cause a tube failure at Surry 2 in 1976. The licensee, knowing that IP2 had severe denting, should have been expecting abnormally high stress at the apex of the small radius U-Bends. The licensee did not take appropriate actions when PWSCC was detected for the first time in the apex of a small radius U-Bend.

Industry position:

The Steam Generator Integrity Assessment Guidelines, Revision 1, Section 3 states that "it is essential to know the condition of the steam generators as defined by the last plant outage and to anticipate its condition at the upcoming outage." This would require consideration of relevant operating experience. "Anticipating newly developed forms of degradation will allow thoughtful preparation of inspection sample and expansion plans and identification of applicable NDE equipment, techniques, personnel, and disposition requirements."

The PWR Steam Generator Examination Guidelines: Revision 5, Volume 1, Section 5.2, requires a degradation assessment. Utilities are required to assess all active and potential degradation mechanisms. "The purpose of the assessment is to ensure that inspection techniques and personnel used for the detection and sizing of flaws are appropriate for all existing and potential degradation mechanisms. "

NEI 97-06, Section 3.1.1, further requires the degradation assessment to consider operating experience from other similar steam generators.

Immediate industry actions:

None

Future actions to be tracked by SGMP:

None

Resolution status:

RIS – 2: Assess Root Cause for all Degradation Mechanisms

Adequate industry guidance has been issued to address this issue.

Issue 2 is NRC's concern that the licensee did not assess the root cause of an apex PWSCC indication knowing that IP2 had the initiator to abnormally high stress at the apex of the low row U-Bends. No investigation was done as a result of finding an apex indication.

Industry position:

NEI 97-06, Section 3.1, requires licensees to perform an assessment of existing degradation mechanisms. The assessment addresses 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 also considers operating experience from other similar steam generators and engineering analyses of the degradation mechanisms.

The PWR Steam Generator Examination Guidelines: Revision 5, Section 5, Steam Generator Assessments, requires a number of assessments for operating steam generators. An assessment of both existing and potential degradation mechanisms is required prior to each inspection. A condition monitoring assessment is required after each inspection to ensure the steam generators met the performance criteria during the operating cycle prior to the inspection. An operational assessment is performed following an inspection to ensure that the performance criteria will be met at the end of the next operating cycle. Finally, a self-assessment is required to ensure that the entire steam generator program is acceptable.

The Steam Generator Integrity Assessment Guidelines, Revision 1, also require a degradation assessment, and states that it is essential to know the condition of the steam generators as defined by the last plant outage. Appendix A of this guideline is an example of a degradation assessment. Part of the discussion of each active degradation mechanism is an engineering evaluation of the cause of the degradation.

The Chairman's letter to the SGMP, "SGMP Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues, dated September 29, 2000, encouraged utility personnel to consider potential initiators or accelerators of degradation, such as induced stresses from tube support denting, to accurately anticipate degradation.

Immediate industry actions:
None

Future actions to be tracked by SGMP:
None

Resolution status:

Industry Response (NRC Summary):

Adequate industry guidance has been issued to address these issues.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The EPRI tube integrity assessment guidelines, Section 3 and Appendices A and B, currently only provide general guidance pertaining to these issues. The SGMP Information Letter dated September 27, 2000 contains useful information which should be incorporated into the guidelines, but again is still very general. The guidance is not of sufficient detail to enable the user to anticipate or recognize the many types of degradation mechanisms or developing failure mechanism precursors such as those at Indian Point 2 prior to the 2000 failure event.

The tube failure events at Ginna in 1982 and at Indian Point 2 in 2000 could have been prevented had there been a better understanding of the root causes associated with previously observed degradation.

EPRI and other industry and NRC publications do provide useful information on these issues as is noted in the guidelines. The staff believes that the industry should consider development of detailed guidelines for performing degradation assessments which pulls this information together.

In summary, the staff believes that more detailed industry guidance is needed relative to these issues and, therefore, these issues remain open. Such guidance would be expected to further enhance the effectiveness of utility programs to ensure tube integrity. These issues do not pose a significant safety concern, given current regulatory requirements and current industry practices for ensuring SG tube integrity. The staff considers these issues to be medium priority. These issues are not expected to impact the staff's review of the NEI SG generic change package.

Additional Industry Comments (8/9/02):

Interim guidance issued by the SGMP is incorporated into the following revision of the guidelines. Revision 6 of the SG Examination Guidelines includes additional guidance on degradation assessments. The Integrity Assessment Guidelines are in the process of being revised. Additional guidance will be developed.

Issue LL 2e and 2f from Lessons Learned Report:

Industry should update the EPRI SG Examination Guidelines to incorporate guidance on how to evaluate flow slots for hour-glassing and the impact of hour-glassing on PWSCC in low row u-bends.

Initial Industry Response (8/1/01):

LL2e: Inspection for Hourglassing and its Implications
LL2f: Definition of Significant Hourglassing

These two issues are NRC's concerns that IP2's licensee did not consider the highly stressed area of the low row U-bends, trace the cause to flow slot hour-glassing, and take appropriate actions. The NRC is concerned that guidance does not exist to address this situation.

Industry position: Existing industry guidance is adequate.

There are two prerequisite conditions to seventh support plate or upper support plate flow slot hour-glassing inducing ovalization in inner radius recirculating steam generator design U-Bends with drilled carbon steel support plates.

1. Extensive hot leg tube support plate corrosion-induced tube denting is necessary to produce plastic deformation of the tube. This denting would have to be severe enough to reduce the inside diameter to the point that standard diameter straight leg eddy current probes would not pass through the tube, i.e., in 7/8" diameter tubes, the standard diameter bobbin coil probe is 0.720". Therefore, if an examination utilized standard diameter probes, the flow slot hour-glassing distortion could not exist.
2. With the extensive tube support plate corrosion-induced denting, plastic deformation of the support plate drilled holes and flow holes would produce a force sufficient to crack support plate drill hole ligaments and result in extensive ligament cracking indications at the lower to upper support plate locations.

The conditions necessary to produce inner radius U-Bend ovalization associated with flow slot hour-glassing would be identified in a required degradation assessment as part of the site steam generator program.

A detailed explanation of steam generator tube denting, tube support plate cracking, flow slot hour-glassing, and inner radius U-Bend PWSCC is available in the Steam Generator Reference Book TR-103824, Section 8.

Industry guidance does not exist to explicitly address hour-glassing, nor do the guidelines address every possible cause of degradation. However, guidance does exist that requires a licensee to evaluate the condition of the generators and EPRI technical reports and workshops assist the licensee in this evaluation.

NEI 97-06, Section 3.1.1, requires a degradation assessment, which includes "the components that support the pressure boundary, such as secondary side components." Section 3.1.6 requires maintenance of secondary-side integrity, which includes "monitoring if their failure could prevent the steam generator from fulfilling its intended safety-related function. The monitoring shall include industry experience." Specifics of the secondary side inspections are required to be documented in the plant's Steam Generator Program by Section 3.2.

The Steam Generator Integrity Assessment Guidelines, Revision 1, Section 3 requires a degradation assessment, which includes identifying "previously identified and potential degradation forms on both the secondary and primary sides of the steam generator that affect tubing, support structures, pressure and leak boundaries."

The PWR Steam Generator Examination Guidelines: Revision 5, Volume 1, Section 5.2, requires a degradation assessment. This assessment shall address existing and potential degradation associated with tubes, tube supports, sleeves, plugs, and all other types of repair.

The SGMP has issued technical reports that are available to the industry that address this issue:

The Steam Generator Reference Book TR-103824, Section 8 includes a discussion on hour-glassing.

EPRI WS-80-136, Workshop Proceedings: U-Bend Tube Cracking in Steam Generators includes a paper on Factors Affecting U-Bend Cracking

EPRI NP-5282, "Residual and Applied Stress Analysis of Alloy 600 Row 1 U-Bend" includes a discussion on effects of lateral displacement.

EPRI TR-104030, "PWSCC Prediction Guidelines" provides information on assessing U-Bend cracking including accounting for effects of lateral displacement.

It is industry's position that each licensee should address the conditions of the steam generators. Guidance can not be developed for every possible mechanism.

Immediate industry actions:

None

Future actions to be tracked by SGMP:

None

Resolution status:

Industry Response (NRC Summary):

Existing industry guidance is adequate. Although guidance does not exist which explicitly addresses hour-glassing, the tube integrity assessment guidelines require a degradation assessment, which includes identifying previously identified and potential degradation forms that affect the tubing, support structures, pressure and leak boundaries. Such a degradation assessment would identify the conditions necessary to cause hour-glassing. A detailed explanation of steam generator tube denting, tube support plate cracking, flow slot hour-glassing, and inner radius u-bend PWSCC is available in the EPRI Steam Generator Reference Book TR-103824, Section 8.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The staff believes the industry guidelines for degradation assessment are too general to ensure that licensees will recognize or anticipate conditions such as the hour glassing condition which led to the tube failure event at Indian Point 2. The licensee's mantra was that it was fully following applicable guidelines both before and after the failure event. However, subsequent to the event, the licensee learned of hour-glassing at the top-most support only after being urged by NRC to use a measuring implement rather than simply relying on visual observations with a remote camera.

More detailed guidance is needed to ensure that all potential degradation mechanisms are considered in the degradation assessment and that potential precursor conditions are recognized. For example, guidance is needed with respect to implications of denting, denting thresholds at which hour-glassing poses a potential concern, and methods for detecting hour-glassing at the top-most support.

The staff acknowledges that EPRI and other industry and NRC publications do provide useful information on these issues as is noted in the guidelines. The staff believes that the industry should consider development of detailed guidelines for performing degradation assessments which pulls this information together.

In summary, the staff believes that more detailed industry guidance is needed relative to this issue and, therefore, this issue remains open. Such guidance would be expected to further enhance the effectiveness of utility programs to ensure tube integrity. This issue does not pose an immediate or significant safety concern in-of-itself, given the heightened awareness of licensees to NDE data quality issues (another important causal factor related to the Indian Point event) and current industry efforts to update the guidelines to incorporate data quality criteria. The staff considers this issue to be medium priority. This issue is not expected to impact the staff's review of the NEI SG generic change package.

Additional Industry Comments (8/9/02):

Additional guidance will be developed for performing degradation assessments. Revision 6 of the SG Examination Guidelines was recently revised to include this guidance. The Integrity Assessment Guidelines are in the process of being revised.

Issue 2k from Lessons Learned Report:

Industry should update the EPRI SG Examination Guidelines to incorporate guidelines on prudent measures to be followed in when evaluating the first occurrence of a new type of degradation for SG tubes.

Initial Industry Response (8/1/01):

LL 2k: Prudent Measures Upon finding New Degradation Michanisms

Industry position: Enhanced guidance will be developed.

Additional guidance has been developed in Revision 6 of the EPRI PWR Steam Generator Examination Guidelines to address this issue. Specifically, Section 5.2 "Degradation Assessment" was changed and now contains the phrase "If a damage mechanism is identified during the inspection and was not addressed in the current degradation assessment, then the degradation assessment shall be revised during the inspection".

Immediate industry actions:

None

Future actions to be tracked by SGMP:

Issue Revision 6 of the PWR Steam Generator Examination Guidelines by January 2002.

Resolution status:

Industry Response (NRC Summary)

Enhanced guidance will be developed.

Additional guidance has been developed in Revision 6 of the EPRI PWR Steam Generator Examination Guidelines to address this issue. Specifically, Section 5.2 "Degradation Assessment was changed and now contains the phrase "If a damage mechanism is identified during the inspection and was not addressed in the current degradation assessment, then the degradation assessment shall be revised during the inspection."

The response to LL 2l is also applicable to this issue.

Immediate industry actions: None

Future actions to be tracked by the SGMP: Issue Revision 6 of the PWR Steam Generator Examination Guidelines by January 2002.

Staff Evaluation:

The staff concludes that the above response and that provided for issue LL2I to be responsive to this issue and will consider this issue closed, subject to issuance of Revision 6 of the examination guidelines incorporating the above changes and the industry position described in response to LL 2I.

Issue LL 2I from Lessons Learned Report:

When a new type of steam generator tube degradation occurs for the first time, licensees should determine the implications on steam generator condition monitoring and operational assessments (e.g., potential for the tube to rupture before the leaking such as at the apex of a small radius u-bend).

Initial Industry Response (4/26/01):

LL 2I: Tube Integrity Implications of New Mechanisms

Industry acknowledges the need to improve guidance in this area.

During the NRC's review of the IP2 tube failure event, it was noted by the staff that the licensee did not take appropriate actions when they identified axial PWSCC at the apex of a low row U-Bend for the first time.

Industry position:

For newly active degradation modes that were not considered to be potential degradation mechanisms in the degradation assessment, the licensee should enter the issue into their corrective action program at a significance level that requires a root cause analysis to be performed, i.e., a Significant Condition Adverse to Quality as defined by 10CFR50 Appendix B. The degradation assessment and inspection plan should be reviewed and revised as necessary to ensure that the necessary data is available to allow the operational assessment to address potential effects of the new degradation mechanism. Corrective actions to bound the extent of condition, such as requiring additional inspections prior to unit restart, may be a result of this review. When developing corrective actions, consideration should be given to the effects of plant chemistry, individual plant operating experience, and other causal factors. Degradation that was expected but not previously active that was addressed in the plant-specific degradation assessment and inspection plan does not need to be entered into the plant corrective action program.

Immediate actions: None

Future actions to be tracked by SGMP: SGMP will issue an industry letter providing the above guidance by August 31, 2001.

Resolution status:

Industry Response (NRC Summary):

For newly active degradation modes that were not considered to be potential degradation mechanisms in the degradation assessment, the licensee should enter the issue in their corrective action program at a significance level that requires a root cause analysis to be performed. Additional general guidance to this effect is provided. Degradation that was expected but not previously active that was addressed in the plant specific degradation assessment and inspection plan does not need to be entered into the plant corrective action program.

No immediate industry actions are necessary.

Future action to be tracked by SGMP: SGMP will issue an industry letter providing the above guidance by August 31, 2001. **(Jim, was this done? Need reference and copy.)**

Staff Evaluation:

U-bend PWSCC was an expected degradation mechanism at Indian Point 2. However, u-bend PWSCC driven by stress induced by flow slot hourglassing was not anticipated at Indian Point 2. The licensee assumed incorrectly that the u-bend PWSCC found in 1997 was the expected form of PWSCC. Thus, this finding would not likely have entered the corrective action program under the industry's new guidance. Issues 1 and 2 from RIS 2000-22 capture the Indian Point situation.

The new industry guideline is clearly worthwhile and on this basis, **and subject to its future incorporation into the applicable EPRI guideline documents [Jim, is this the industry's intent?],** the staff concludes that issue LL 2l is closed.

Additional Industry Comments (8/9/02):

SGMP issued an interim guidance letter on this subject on August 31, 2001. A copoy was sent to the NRC.

Interim guidance is incorporated into the following revision of the EPRI Guidelines. The Integrity Assessment Guidelines are currently in the revision process.

Issue LL 2o from Lessons Learned Report:

The Task Group notes that its recommendations on eddy current testing and tube inspection guidelines were focused on a particular situation that existed at IP2 (i.e., a specific type of degradation and location within the SG). While incorporation of the IP2 lessons into industry guidelines is important, further development of industry guidelines should also address all SG tube degradation modes and degradation locations in order to be generally applicable.

Initial Industry Response (8/9/02):

LL 2o: Address all Degradation Modes and Locations

Industry position:

All the industry guidelines are subject to revision every two years. Revisions are driven for example by field experience, improvements in technology, new information as a result of R&D efforts, as well as industry events. The guidelines committees that are revising guidelines at this time are not focused only on the event at IP2, but are incorporating lessons learned from all aspects of steam generator inspection, maintenance, and operation.

Immediate actions:
None

Future actions to be tracked by SGMP:
None

Resolution status:

Issue 3 of RIS 2000-22:

Data quality depends on the degree to which the eddy current signal from a flaw can be masked or distorted by signals from sources other than the flaw. Data quality directly affects the ability to detect and size flaws. The signals from sources other than the flaw are often called “noise”. The amplitude of the noise signal and signal-to-noise ratio are important measures of data quality.

Issue LL 2a from Lessons Learned Report:

The industry should update the EPRI PWR SG Examination Guidelines to incorporated data quality criteria. Guidelines should explicitly discuss how to identify excessive noise in the data, how to identify the source of the noise, and what to do about the noise after the source is identified.

Initial Industry Response (4/26/01):

RIS 3 and LL 2a: Need for Data Quality and Acceptance Criteria

Industry Position: Enhanced guidance will be developed

Specific and detailed requirements for data quality parameters are in preparation for inclusion in Revision 6 of the EPRI SG Examination Guidelines. These requirements address data quality parameters associated with a generic eddy current probe as well as specific probe types (bobbin, rotating coil, plus point, array) that are commonly used in the field. In addition, probe-manufacturing quality parameters will be developed.

Immediate industry actions: None

Future actions to be tracked by SGMP: Issue Revision 6 of the PWR Steam Generator Examination Guidelines by January 2002.

Resolution status:

Industry Response (NRC Summary):

Specific and detailed requirements for data quality parameters are in preparation for inclusion in Revision 6 of the examination guidelines.

No immediate industry actions are necessary.

Future actions to be tracked by SGMP: Issue Revision 6 of the PWR Steam Generator Examination Guidelines by January 2002.

Staff Evaluation:

Draft guidelines for inclusion into Revision 6 of the EPRI examination guidelines are under staff review. The staff considers this to be an open and high priority issue since poor data quality can significantly degrade the effectiveness of inservice inspection, condition monitoring, and operational assessment. This issue does not pose an immediate safety concern. Based on staff discussions with a number of licensees, the high noise levels seen at Indian Point 2 are not typically seen elsewhere in the industry. The SGMP has alerted the industry to the issue and provided general guidance in its information letter dated September 29, 2000. In addition, feedback from licensees during outage phone calls indicates they are aware of the industry and taking steps to ensure adequate data quality. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

Section 6.5 of Revision 6 of the PWR Examination Guidelines adequately addresses data quality Issues

Section 6.5 of Revision 6 of the PWR SG Examination Guidelines provides the requirements for data quality in eddy current examination of SG tubes. Data quality parameters are divided into 4 tables and are separated as generic (Table 6-3), bobbin (Table 6-4), rotating plus point or rotating pancake (Table 6-5) and array probes (Table 6-6). The tables provide a frequency, location, acceptance criteria, and corrective action for each of the listed quality parameters.

Each technique, described in its ETSS, contains an area of test applicability and a noise value for each flaw in the ETSS. Measurement of noise is described in Section H2.3.3 of Rev. 6. Exceeding the data quality acceptance criteria for noise shall require additional action that may include one or more of the following:

- re-collection of data,
- change of technique,
- determine whether the flaws in the ETSS can be detected in the higher noise levels of plant data,
- adjustments to POD and sizing,
- change of inspection interval length, or
- repairing of the tube.

Revision 6 of the PWR Steam Generator Examination Guidelines was approved on August 6, 2002.

Issue LL 2b of Lessons Learned Report:

Industry should consider the issue of noise in newer tubes in the revision to the EPRI SG Examination Guidelines.

Initial Industry Response (4/26/01):

LL 2b: Data Quality for New Tubing

Due to the high noise levels found on some samples in the U-bend ETSS, the NRC implies that noise can be present in the U bends of newer samples and that the industry should carefully assess the potential for conditions detrimental to detecting flaws at each plant.

Industry Position: Existing industry guidance is adequate.

Tubing for the qualification of techniques should be representative of what is found in service. The higher noise level samples used in the EPRI qualification makes the technique uncertainty values conservative.

The industry has developed manufacturing specifications as reported in "Guidelines for the PWR Steam Generator Tubing Specifications and Repair Volume 2, Revision 1: Guidelines for Procurement of Alloy 690 Steam Generator Tubing". TR-016743-V2R1. These guidelines set the signal to noise ratio for new steam generator tubes at 15:1. This specification has generally been adopted by utilities that have replaced their steam generators. Improvements in materials and manufacturing processes in recent years has typically produced SG tubes that exhibit average signal to noise ratios of 30:1 for pilgered tubes and 50:1 for drawn tubes.

The original version of these guidelines contained an 5 % ovality requirement The current version is 3 % due to improvements in bending techniques. In addition, stress relief is required for U-bends with a bend radius less than 10 times the OD of the tube.

Immediate industry actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry Response (NRC Summary):

The EPRI SG examination guidelines provide that qualification data sets should be representative of those in the field in terms of noise and signal to noise.

The industry has developed guideline manufacturing specifications for Alloy 690 SG tubing, with minimum allowable S/N ratio of 15:1. Improvements in materials and manufacturing processes in recent years have typically produced tubes with S/N ratios of 30:1 for pilgered tubes and 50:1 for drawn tubes.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The industry is requested to provide additional information with respect to its response. These questions relate to tube noise (e.g., inner diameter surface irregularities), rather than noise not related to the tubing itself such as surface deposits or noise associated with electronics.

1. What is the range of plant average S/N ratios with Alloy 600 MA tubing? How much S/N variability among tubes at a plant is typically observed?

2. Same questions for Alloy 600 TT.

3. Same questions for Alloy 690 TT.

4. What is the range of the average S/N ratios for the tubes used for the various ETSS data sets

5. Are there plants where the average S/N ratio is less that the average S/N ratio for the ETSS qualification data sets? If so, are the affected utilities obliged to supplement the ETSS data set for their application? Are the guidelines specific on this point?

The staff acknowledges that the EPRI examination guidelines contain general guidelines concerning the need for qualification data sets to incorporate noise levels which are representative of those in the field. The above information will provide the staff with additional insight on the variability of tubing noise seen throughout the industry and how the industry is actually handling this issue under the guidelines.

The staff considers this to be an open, high priority issue with no immediate safety concerns. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

Revision 6 of the PWR Steam Generator Examination Guidelines provides adequate guidance in this area.

Section 6.5 of Revision 6 of the PWR SG Examination Guidelines addresses the noise in SG tubing (old and new) and provides the requirements for measuring noise for each flaw in each ETSS to be compared to in in-generator noise in the area of test applicability. Exceeding acceptance criteria for noise shall require additional actions that are specified in the above section of the Guidelines.

Additionally, tubing used for qualification of techniques had been selected to be representative of what is found in service. The higher noise level samples used in the EPRI qualifications make the technique uncertainty values conservative for new tube materials that are less noisy.

Noise values are being compiled and incorporated in ETSS's. As time progresses, noise values for SG tubes in various plants will be measured and compiled, per requirements of Section 6.5 of Rev. 6 of the PWR SG Examination Guidelines, and that will allow comparison of ranges of S/N ratios among Alloy 600TT and Alloy 690TT plants.

Revision 6 of the PWR Steam Generator Examination Guidelines was approved on August 6, 2002.

Issue LL 2c of Lessons Learned Report:

The EPRI Guidelines should address noise minimization techniques such as filtering algorithms.

Initial Industry Response (4/26/01):

LL 2c: Use of Noise Minimization Techniquews

Industry Position: Existing guidance is adequate.

The PWR SG Examination guidelines currently consider filtering algorithms as essential variables which must be demonstrated through Appendix H technique qualification (H.2.1.1, H.4.2). The industry has filtering algorithms and other noise suppression techniques that can be applied to data. The essential variables of techniques must be controlled so consistent results are obtained.

Immediate industry actions: None

Future actions to be tracked by SGMP: None.

Resolution status:

Industry Response (NRC Summary):

The EPRI SG examination guidelines currently consider filtering algorithms as essential variables which must be demonstrated through the Appendix H technique qualification.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The staff concludes that the guidelines do address noise minimization techniques and, thus, this issue may be considered closed.

Issue 4 from RIS 2000-22:

Non-destructive examination (NDE) qualification programs that include tube samples representative of those in the field.

Initial Industry Response (4/26/01):

RIS 4: Use Realistic Flaws

Industry Position: Existing guidance is adequate in the area.

Requirements for qualification samples are specified in Supplement 2, Appendix H of Revision 5 of the SG Examination Guidelines. Section H2.2.1 requires that qualification data sets shall consist of flawed grading units and shall be established for each of the damage mechanism categories. It is further stipulated that flawed grading units shall consist of damage mechanisms/extraneous test variable combinations applicable to the scope of the examination procedure. Where actual field samples in the form of pulled tubes are not available, the Guideline allows test samples fabricated using mechanical or chemical methods. The Guideline, however, clearly states that such fabricated flaws should produce signals similar to those being observed in the field in terms of signal characteristics, signal amplitude, and signal to noise ratio.

Development of realistic flaw sets for testing and qualification of eddy current techniques has been a particularly challenging problem for the industry (including the NRC Research program aimed at assessing the industry practices). While the ideal flaw set continues to be a collection of defective tubes removed from service, the very limited number of available pulled tubes, and statistical requirements of qualification flaw sets forces the industry to resort to other alternatives such as laboratory produced machined flaws and chemically induced defects. Machining and other mechanical means can adequately simulate certain damage mechanisms such as wear and denting, but not stress corrosion cracks. EPRI SGMP has been aware of this problem and has had an aggressive program to develop the know-how and to produce realistic cracks in various steam generator tube locations. As realistic samples become available, the industry continuously updates technique qualification parameters (Examination Technique Specification Sheets, ETSS). Pulled tube data and laboratory produced crack samples replace machined defects in qualification flaw sets and modify qualification parameters as warranted.

Concerns have been expressed regarding the potential widespread use of EDM notches in Appendix H qualifications. Although not precluded, the use of EDM notches is limited to a very small subset of qualifications. For volumetric flaws such as thinning, wear and impingement, EDM simulated defects adequately resemble the type and size of degradations seen in the field. Their associated current ETSS's (as of February 14, 2001) reflect a total of 17 techniques where each technique represents a unique flaw/location/probe configuration. Based on a particular probe used, some flaw samples are often used in multiple technique qualifications. For example, ETSS's for volumetric flaws contain 392 signals coming from machined flaws, 48 signals coming from EDM notches, 24 signals coming from pulled tubes, and 389 signals coming from chemically induced volumetric indications. For ETSS's related to cracking, there are currently a total of 39 techniques that utilize 149 signals from EDM notches, 511 signals from laboratory induced cracks, 201 signals from pulled tubes and it should be noted that all of the 149 EDM signals are in the U-bend qualifications. The U bend samples are being replaced with laboratory produced cracks. Five techniques are currently awaiting peer review and they contain 128 signals from laboratory cracks, 42 signals from pulled tubes, and 45 signals from EDM notches where all of the 45 EDM signals are located in sleeve samples.

Immediate industry actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry Response (NRC Summary):

The EPRI PWR SG Examination Guidelines adequately address this issue.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The staff acknowledges that the guidelines do address this issue. The staff also acknowledges the industry's intent to further strengthen the guidelines to this effect in Revision 6 of the guidelines.

The staff's long standing concern in this area is that a number of Appendix H qualification data sets did include EDM notches to simulate cracks; this despite the fact that the Appendix H guidelines have provided that the data set should be representative of real flaws. The industry was not implementing Appendix H consistent with the Appendix H guidelines.

The industry response states that the EPRI SGMP has been aware of this problem and has had an aggressive program to develop the know-how and to produce realistic cracks in various steam generator locations. U-bend EDM notch samples are currently being replaced with laboratory produced cracks; however, there remains a pending qualification for sleeves that still relies on EDM notches.

The staff concludes that the industry appears headed on a path to resolve this issue. The staff hopes to be able to consider this issue closed once revision 6 to the guidelines has been issued. In the meantime, the staff considers this to be an open, medium priority issue with no immediate safety concerns. This issues is not expected to impact the staff's review of the NEI generic change package.

Additional Industry Comments (8/9/02):

Existing guidance, Rev. 5 PWR SG Examination Guidelines, and its pending Rev. 6 are adequate in this area.

ETSS's for volumetric flaws contain 392 signals coming from machined flaws, 48 signals coming from EDM'd flaw representations, 24 signals coming from pulled tubes, and 389 signals coming from chemically induced volumetric indications. For ETSS's related to cracking, there are currently a total of 39 techniques that utilize 147 signals from EDM notches, 511 signals from laboratory induced cracks, 201 signals from pulled tubes and it should be noted that all of the 147 EDM signals are in the U-bend qualifications. The 147 EDM signals are represented 7 of the 39 techniques. Each of the 7 techniques utilize the same 21 EDM signals. The U bend samples are being replaced with laboratory-produced cracks as these cracks are becoming available on a continual basis.

Revision 6 of the PWR Steam Generator Examination Guidelines was approved on August 6, 2002.

Issue 5 from RIS 2000-22:

Site-specific qualifications of generically qualified techniques ensuring an application is consistent with site-specific conditions and that appropriate NDE performance capabilities are considered in operational assessments (e.g., POD of flaws and flaw size measurement error).

Issue LL 2d of Lessons Learned Report:

The licensees should review industry guidelines carefully to ensure that the conditions/assumptions supporting the guidelines apply to their plant-specific situation (for example, site-specific performance demonstrations for examination techniques).

Issue LL 2g of Lessons Learned Report:

Site validation of techniques should be used for each detection technique, focusing on the most challenging areas of degradation.

Initial Industry Response (4/26/01):

RIS 5, LL 2d, LL 2g: Site Specific Qualification:

Industry Position: Enhanced guidance will be developed.

Site qualification of examination techniques is described in Section 6.2.4 of the Revision 5 of the EPRI PWR SG Examination Guidelines. The purpose of the site qualification of examination techniques is to ensure that the detection and sizing capabilities developed in accordance with Appendix H is applicable to site-specific conditions. This shall be accomplished through a documented review of a qualified technique's tubing-essential-variables (e.g., denting, deposits, tube geometry changes, and signal characteristics) to ensure that the application is consistent with site-specific steam generator conditions. The review shall establish that tubing essential variables of the flawed tubes in the data set are similar in voltage and signal-to-noise to expected in-generator signals.

It is important to note that if the review does not show similarity of tubing essential variables, the technique is not considered site-qualified. If the data set used in the technique qualification is not representative of the current field conditions, then additional technique qualification on a data set having tubing essential variables similar to site specific steam generator conditions, shall be performed meeting the statistical requirements of Appendix H. This additional qualification may necessitate pulling one or more tubes.

The SG Examination Guidelines further stipulates in Sec. 6.2.4 that if a site qualified technique cannot be established, then in-situ pressure test results must be used to obtain supplemental data supporting tube integrity assessments.

The description and details of site specific validation will be further strengthened in Revision 6
These issues were also discussed in a letter "Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues" dated September 29. 2000, from Larry Womack.

Immediate industry actions: None

Future actions to be tracked by SGMP: Issue Revision 6 of the PWR Steam Generator Examination Guidelines by January 2002.

Resolution status:

Industry Response (NRC Summary):

Site-specific qualification of techniques and data analysts are addressed in Revision 5 of the EPRI PWR SG Examination Guidelines. The description and details of site-specific qualification will be further strengthened in the forthcoming Revision 6.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The staff concurs that Revision 5 of the guidelines addresses site-specific qualification of NDE techniques and data analysts. The 1997 SG inspection pre-dated revision 5 of the guidelines. These guidelines could have alerted the licensee that the generic Appendix H qualification of the mid-range plus point probe for u-bend inspection might not necessarily apply to the IP-2 u-bends by virtue of the relatively high noise levels at IP-2. However, it would not have guided the licensee to take actions which would have led to the detection of the flaw which subsequently failed in service.

The guidelines appropriately recommend that a supplemental, site-applicable performance demonstration (which may involve obtaining pulled tube specimens) be performed in cases where the generic qualification does not address site-specific conditions. However, in cases where site-applicability of a generically qualified technique cannot be established, revision 5 of the guidelines states that in situ pressure test results may be used to obtain supplemental data supporting tube integrity assessments. Following this guidance and the EPRI SG In Situ Pressure Test Guidelines likely would not have revealed that significant indications were not being detected by the mid range probe at IP-2 and, therefore, would not have averted the subsequent tube failure event. In general, the staff believes that in situ pressure testing does not provide sufficient evidence in-of-itself that NDE detection capability is adequate to detect significant flaws under site-specific conditions.

The staff also notes that revision 5 of the examination guidelines, and other EPRI guideline documents (i.e., tube integrity assessment, in situ testing) need to provide improved guidance on the necessary attributes of a qualification or performance demonstration in order to quantify NDE detection and sizing performance for purposes of supporting tube integrity assessments. Specific comments in this regard are presented in the staff's paper entitled "Technical Issues/EPRI Guideline Documents."

In summary, revision 5 of the examination guidelines discusses key issues relating to determining the site applicability of generic NDE qualifications. The forthcoming revision 6 of the guidelines is expected to further enhance this guidance, particularly with respect to establishing whether site-specific noise conditions are within that considered in the generic qualification. However, future revisions to the guidelines need to better address the issues as to whether there are acceptable alternatives to the use of site-qualified NDE and, if so, what the alternatives are. In addition, improved guidance is needed to address the necessary attributes of a qualification or performance demonstration in order to quantify NDE detection and sizing performance for purposes of supporting tube integrity assessments.

The staff considers these issues to be open, high priority issues since they pertain to the effectiveness of tube integrity assessments. These issues may be relevant to technical bases for longer inspection intervals which may be proposed by industry in the future. These issues do not pose an immediate safety concern since tube integrity assessment is not a current a regulatory requirement. Despite existing shortcomings in tube integrity assessments, tube integrity assessments extend beyond current regulatory requirements and have provided added assurance of SG tube integrity. Thus, these issues do not pose an immediate safety concern. Nor do these issues impact the staff's review of the NEI SG generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

Revision 6 of the EPRI SG Examination Guidelines no longer stipulate that in situ pressure test results may be used to obtain supplemental data supporting tube integrity assessments if a site specific technique cannot be established (See section 6.2.4).

Revision 6 of the PWR Steam Generator Examination Guidelines was approved on August 6, 2002.

Issue LL 2n from Lessons Learned Report:

The data analyst's job is tedious and performed under severe time constraints, and thus prone to the possibility of missing indications. There are data screening computer programs that will enhance (not replace) the detection capability of the analysts in some situations.

Initial Industry Response (4/26/01):

LL 2n: Computer Data Analysis

Industry Position: Existing guidance is adequate.

The industry currently recommends independent dual analysis teams. The results of each team are then resolved by a QDA. Currently one of those analysis methods may be automated. Computer analysis guidance (SG Examination Guidelines, Rev. 5, Vol. 1, Sec. 6.3.3.3) already exists. To further enhance reliability of data analysis, there is also industry guidance for the use of an independent QDA (Sec. 6.3.3.4) and Field Analysis Feedback (Sec. 6.6) in the SG Examination Guidelines. As additional experience is gained with analysis algorithms, and with improvements in technology, the use of computer data analysis will increase. The industry guidance will in time be updated to take advantage of the gained experience and improvements in the technology.

Immediate industry actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry Response (NRC Summary):

Adequate industry guidance has been issued to address this issue and includes guidance pertaining to computerized data analysis. As additional experience is gained with analysis algorithms, and with improvements in technology, the use of computer data analysis will increase. The industry guidance will be in time updated to take advantage of the gained experience and improvements in the technology.

There is also guidance on process controls such as the use of independent duel analysis teams with a separate discrepancy resolution team. The guidelines instruct licensees to establish policies on noise levels, music, and work hours. In addition, there is guidance for the licensee to designate an experience analyst, who is not part of the resolution team, to randomly sample the data to ensure that the resolution process was properly performed and theat the field calls were properly reported. Each analyst is to receive feedback on missed calls.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

Existing guidelines address the staffs concerns in his area. The staff concludes this issue is closed.

RIS 2000-22 Issue 6:

Consideration of flaw size measurement error when applying the threshold screening criteria for selection of tubes for in situ pressure testing.

Initial Industry Response (8/1/01):

RIS 6, LL 2h, LL 2i: In Situ Test Screening Criteria

Lessons Learned Issue LL2h states that "*Licensees should use a conservative approach to screening tubes for in situ testing, and should include tubes with new forms of degradation even if the screening threshold is not met. Industry should modify guidelines on screening criteria to include new forms of degradation*."

RIS Issue 6 results from phone conversations in November 1999 between the NRC staff and the ANO-2 licensee concerning the licensee's plans for in situ pressure testing during the November 1999 mid cycle SG inspection outage.

At ANO-2 six tubes were found to exceed the screening criteria for in situ pressure testing. The licensee initially determined that four of the six tubes did not need to be tested since the NDE measured size of the respective flaws were bounded by the size of flaws pressure tested in situ during a previous inspection outage. After discussions with the NRC staff, the licensee decided to test these tubes. The staff noted that the screening criteria, in accordance with the EPRI guidelines, are intended to account for NDE test flaw size measurement uncertainty.

Testing on one of the four tubes was terminated at a pressure below the 3 delta P criterion when leakage through the flaw exceeded the capacity of the system. After reviewing the circumstances of the test, the staff concluded that the tube was about to burst when the test was terminated. This conclusion is discussed under Issue 7 and in more detail in the NRC letter dated May 2, 2000 (Accession No. ML003710343). This experience underscores the importance of allowing for flaw size measurement errors (in accordance with the EPRI guidelines) when selecting tubes for in situ pressure testing.

NRC Lessons Learned Report Issue 2h summarizes the NRC Staff's position that tube R2C67 at Indian Point 2, should have been included as an in situ candidate, even though NDE sizing of the indication indicated that the structural and leakage performance criteria was satisfied in accordance with current EPRI guidance. The basis for the position was that new types of degradation should be considered for testing regardless of screening results. It should be noted that the EPRI In Situ Guidelines were not issued until June 1999, and were therefore not available during the 1997 inspection at Indian Point 2.

Industry position: Existing industry guidance is adequate.

The NRC discussion identifies three (3) concerns regarding in situ candidate screening. The first re-emphasizes the need to consider measurement error in the evaluation of flaws during condition monitoring. The need to account for measurement error is identified in multiple locations in both the EPRI *In Situ Pressure Test (ISPT) Guideline* and the EPRI *Steam Generator Integrity Assessment Guideline*. It is noted in the guideline documents that there are multiple sources of information for which the applied measurement error can be supported. These include the EPRI ETSS documents that provide datasets of flawed specimens with documented performance results. Site or industry specific tube pull results, previous in situ or laboratory testing can also be used to support the NDE error value selected for the screening of defects. The EPRI SGIA Guideline, Section 4.6 provides requirements regarding the robustness of NDE uncertainty data. The EPRI ISPT Guideline states that the basis for the values should be documented. It is therefore the responsibility of the utility to technically support the values used in the screening assessment.

The ISPT Guideline further states that if sizing capability cannot be characterized, the utility should consider testing a minimum of five indications in an effort to develop an appropriate technical basis for future screening. Finally, the ISPT Guideline provides additional guidance in Section 5.1 for supplemental NDE considerations for questionable or high risk flaws. EPRI issued a letter (Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned for a Review of Recent Steam Generator Related Issues dated September 29, 2000) to members re-emphasizing this requirement in light of events at IP2 and ANO 2.

Based on this re-review of the guidance requirements, it is industry's position that further guidance or emphasis in this area is not needed. It is recognized that continued evolution of sizing information is an objective both generically and for plant specific instances. The industry is continuing to improve flaw specimen data sets, develop new and improved NDE acquisition and analysis technology and develop improved tools for assessing the effects of noise and signal interference. For example, in a continuing effort to provide members with the tools to perform integrity assessment, in 2000, EPRI SGMP modified the information on the EPRI Appendix H ETSS's for each qualified technique to include Integrity Assessment information. The new format includes the NDE sizing uncertainty in terms of standard error of regression. Although this may not be the only or preferred source of NDE uncertainty information, it is provided as a quality controlled data set. This information can be accessed by EPRI members at http://www.epriq.com/. These types of improvements proceed to support guidance requirements and do not obviate a need to change said guidance.

The second issue concerns the need to test "new degradation" regardless of screening results. Industry has acknowledged (See industry response to LL 2L) that some additional guidance is required to address the actions taken upon the discovery of new degradation. The industry response recommends for newly discovered active degradation modes that were not considered to be potential degradation mechanisms in the degradation assessment, the licensee should enter the issue into their corrective action program at a significance level that requires a root cause analysis to be performed, i.e., a Significant Condition Adverse to Quality as defined by 10CFR50 Appendix B. The degradation assessment and inspection plan should be reviewed and revised as necessary to ensure that the necessary data is available to allow the operational assessment to address potential effects of the new degradation mechanism. Corrective actions to bound the extent of condition, such as requiring additional inspections prior to unit restart, may be a result of this review. When developing corrective actions, consideration should be given to the effects of plant chemistry, individual plant operating experience, and other causal factors. Degradation that was expected but not previously active that was addressed in the plant-specific degradation assessment and inspection plan does not need to be entered into the plant corrective action program. These actions are considered appropriate to evaluate the impact of new degradation on growth rate assumptions, size of inspection sample and the adequacy of NDE techniques. With respect to condition monitoring and in situ candidate selection, it is not appropriate to simply require in situ testing of new degradation. In situ screening is morphology dependent, and if the morphology can be adequately characterized, and NDE error values technically supported, condition monitoring can be performed without the necessity of in situ testing if defects satisfy the performance criteria. The ISPT Guideline does acknowledge in Appendix B that the screening recommendations do not address the full range of defect types, NDE capabilities and tubing conditions. As such, other sampling methods, which require lower (or higher) numbers of tests, may be technically justified and documented in the test record. It is therefore industry's position that no changes are required to the ISPT Guideline at this time.

Finally, the NRC Staff identified concerns regarding the use of prior in situ results to eliminate or bound future potential in situ candidates. This issue has been addressed by EPRI SGMP in several forums during 2000. Primarily, the approach to using previous in situ data was addressed in a guideline interpretation by the NEI Review Board. The inquiry and NEI Review Board position (TUBE-2) are reprinted below for information purposes.

TUBE-2 In Situ Testing Screening Criteria4

Inquiry:
How should past in situ pressure test results be used to support/bound threshold screening values as permitted per Section 4.2 of the EPRI in situ pressure test guidelines? What are the key parameters, which should be evaluated?

Response:
Guidance for use of in situ pressure test results for tube integrity assessment is provided in the in situ pressure test guidelines, TR-107620-R1, Section 7.0, Data Analysis. "Applicability of the test data to the operational assessment may require additional engineering evaluation to account for the effects of NDE and material

4 Information reprinted from NEI member website http://member.nei.org

uncertainty. For example, the tube tested may not be representative or bounding of the material variability within the bundle. Further analysis may also be performed to develop a relationship between NDE parameters and non-burst test pressures. Development of this information can lead to assessing structural integrity of indications by use of NDE and calculated structural thresholds. This will assist in further refining screening criteria and may reduce the candidate pool in future in situ pressure testing." The information in the in situ guidelines is supported by discussion in the integrity assessment guidelines, TR-107621-R0, which states "The material properties of the tubes that are tested in situ can vary between steam generators, or even tubes. The burst and leak rate results need to be adjusted to account for these differences. If available, the actual material properties of the tubes at room temperature are documented on manufacturers CMTR's."

In summary past in situ pressure test results or test results from other plants can be used to refine screening criteria or reduce the candidate pool in future in situ pressure testing. However, material and NDE uncertainties must be appropriately applied in addition to other considerations such as test pressures, flaw morphology, NDE technique, tube geometry, etc.

It should also be noted that this Review Board Interpretation was transmitted to the USNRC in a November 9, 2000 letter from Mr. Dave Modeen (NEI) to Mr. Jack Strosnider (USNRC)

In addition to the NEI Review Board Interpretation, several other industry documents were issued to provide either additional guidance or necessary emphasis to reduce the chance that tubes with critical flaws are not tested. For example, SGMP Letter dated October 13, 2000, *Steam Generator Management Program Interim Guidelines on In Situ Pressure Testing of Steam Generator Tubes*, instructed licensees to in situ pressure test all indications above screening criteria not just the worst five indications as currently stipulated in the EPRI In Situ Pressure Test Guidelines. The letter also referred the users to the NEI Review Board Interpretation with respect to ensuring that all input uncertainties be considered when selecting in situ candidates.

Additionally, the NEI Review Board decision was referenced in the September 29, 2000 SGMP letter, *Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues*, in an effort to re-emphasize the issue of using past results to bound current or future indications and to instruct users to use the NEI Review Board process to minimize errors associated with mis-interpretations.

Industry also utilized EPRI SGMP forums and workshops to provide information and training to utility members. The specific lessons learned from the ANO 2 in situ screening were presented at the March 7-8, 2000 EPRI SGMP TAG Meeting in Denver, Colorado and the EPRI Steam Generator Integrity Workshop in Minneapolis, Minnesota on June 6-7 2000.

Through the use of the NEI Review Board, supplemental guidance, and industry forums, it is industry's position that the necessary information to avoid re-occurrence of the circumstances at ANO 2 has been provided. As such, no immediate changes or additional guidance is required. Per EPRI SGMP protocol, the ISPT Guideline is currently in a revision process. The EPRI revision committee is considering specific requirements, which must be met, to permit the use of previous in situ data. The ability to include past plant specific and/or industry in situ data is considered valuable, and the development of a industry accepted generic approach is another example of industry's use of lessons learned and evolving technology to improve steam generator programs. This is considered a basic tenet of the generic licensing approach proposed by NEI.

Immediate actions:

None

Actions to be tracked by SGMP:

Guidance on selection of in situ candidates will be strengthened in the 2001 revision of the In Situ Pressure Test Guidelines to incorporate lessons learned. EPRI SGMP regards this to be a normal course of business activity, and as such, RIS Issue 6 is considered closed

Resolution status:

Complete

Industry Response (NRC Summary):

Existing guidance is adequate.

The need to account for measurement error is identified in multiple locations in both the EPRI In Situ Pressure Test (ISPT) Guideline and the EPRI Steam Generator Integrity Assessment (SGIA) Guideline. The guidelines identify multiple sources of information for which the applied measurement error can be supported including, for example, the EPRI ETSS documents that provide data sets of flawed specimens. The EPRI SGIA guideline, Section 4.6, provides requirements concerning the robustness of NDE uncertainty data. The EPRI ISPT guideline states that the basis for the values used should be documented. It is, therefore, the responsibility of the utility to technically support the values used in the screening assessment.

Based on this review of the guidance documents, it is the industry's position that further guidance or emphasis in this area is not needed. It is recognized that continued evolution of sizing information is an objective both generically and a for plant specific instances. The industry is continuing to improve flaw specimen data sets, develop new and improved NDE acquisition and analysis technology, and to develop improved tools for assessing noise and signal interference.

Finally, the NRC staff identified concerns regarding the use of prior in situ results to eliminate or bound future potential in situ candidates. This issue has been addressed by the SGMP in several forums during 2000. Primarily, the approach to using previous in situ data was addressed in a guideline interpretation by the NEI Review Board. The inquiry and the NEI Review Board position (TUBE-2) were provided to the NRC staff. In addition, several other industry documents were issued to provide either additional guidance or necessary emphasis to reduce the chance that tubes with critical flaws are not tested. For example, SGMP letter dated October 13, 2000, "Steam Generator Management Program Interim Guidelines on In Situ Pressure Testing of Steam Generator Tubes," instructed licensees to in situ [pressure test all indications above the screening criteria, not just the five worst indications as currently stipulated in the ISPT guidelines. The letter referred the users to the NEI Review Board Interpretation with respect to ensuring that all input uncertainties be considered when selecting in situ test candidates. Additionally, the NEI Review Board Interpretation was referenced in the September 29, 2000 SGMP letter, "Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues," in an effort to re-emphasize the issue of using past results to bound current or future indications and to instruct users to use the NEI Review Board process to minimize errors associated with mis-interpretations of the guidelines.

Immediate actions: None

Actions to be tracked by SGMP: Guidance on selection of in-situ pressure test candidates will be strengthened in the forthcoming Revision 2 of the ISPT guidelines to incorporate lessons learned. Thus, RIS issue 6 is considered closed.

Staff Evaluation:

Staff concerns relative to this issue were discussed in detail in the Staff's letter to NEI, dated August 2, 2001 (Accession No. ML012200349). The staff believes that the guidelines should be revised as necessary to address these concerns to ensure that screening criteria appropriately reflect NDE measurement uncertainties. Concerns identified in the staff's August 2, 2001 letter included the following:

> Guidance in the EPRI tube integrity assessment guidelines correctly identifies the need to quantify POD and sizing performance of the NDE system (technique, analyst, and process controls). However, the guidance is not totally consistent on this, particularly for sizing uncertainties. Section 4.6, "Sizing of NDE Indications," makes no mention of the need to consider NDE system sizing performance and seems to imply that sizing uncertainties can be established solely from the Appendix H technique qualification. Figures 8-1 and 9-1 instruct the user to determine NDE sizing uncertainties in accordance with Section 4.
>
> NDE uncertainties must also be considered when determining screening criteria for in situ pressure testing. The guidance on this topic in the EPRI in situ test guidelines are inconsistent with the intent of the EPRI tube integrity assessment

guidelines. There is no mention in the in situ test guidelines of the need to consider sizing uncertainties of the entire NDE system. The in situ test guidelines state in Section B.2.2.H that NDE measurement uncertainty can be found in the ETSS sheets from the Appendix H technique qualification.

The EPRI tube integrity assessment guidelines state that POD performance of the NDE system can be established as the product of the technique POD and the analyst POD. Similarly, NDE system sizing uncertainty can be established as the sum of the technique uncertainty and the analyst uncertainty. The staff notes, however, the Appendix H technique POD and sizing performance is evaluated relative to ground truth whereas the Appendix G analyst performance is evaluated relative to expert opinion. The guideline method for establishing NDE system performance assumes that the experts would perform identically to the Appendix H technique qualification for the same data set. The industry has not documented a technical basis for such an approach.

The EPRI tube integrity assessment guidelines, Section 9.8, ‘Probabilistic Analysis and the Role of Uncertainties,” states that POD is often determined by using teams of analysts reviewing large data sets containing ranges of flaws of known sizes in what is known as a supplemental performance demonstration. This approach is not presented as a guideline concerning acceptable approaches for establishing NDE uncertainties for the total NDE system. It is simply an observation about what some people do. It is not mentioned in Section 4.3, “Probability of Detection,” or in Section 4.6, “Sizing of NDE indications,” or elsewhere in the guidelines dealing with arithmetic or simplified statistical strategies for performing tube integrity assessment. The staff has approved such a supplemental performance demonstration (ARC for PWSCC at dents) for purposes of establishing NDE POD and sizing uncertainties for the entire NDE system to support tube integrity assessments.

Section B.1 of the EPRI in situ test guidelines state that the multi-tiered sequential approach to screening indications (described in Appendix B) is often functionally accurate enough to separate limiting defects even in cases where measurement uncertainty is not fully characterized. The staff agrees that such an approach may be sufficient for prioritizing the tubes for in situ pressure testing, but it is not sufficient to justify not performing in situ pressure tests of a sample of tubes in cases where measurement uncertainty is not fully characterized through performance demonstration (see issues 3 and 5 for additional discussion).

Appendix B.2.C of the EPRI in situ test guidelines state that total measured crack length is conservative due to probe lead in lead out effects and need not be adjusted for measurement error. The staff notes there is evidence from Appendix H qualifications and from operating experience indicating that this statement, as a general statement, is not always correct. The screening process must account for length measurement uncertainty as determined from a performance demonstration (see topic 3).

Appendix B.2.F states that the maximum measured depth may be applied to the limiting depth criterion with no adjustment for depth. This assumption may not always be true. For example, it may not be valid if there are significant uncertainties associated with the depth measurement and/or if the crack depth profile is relatively uniform. Such an assumption should be demonstrated through an appropriate performance demonstration (see topic 3).

The EPRI tube integrity guidelines acknowledge in Sections 4.3, "Probability of Detection," and Section 4.6, "Sizing of NDE Indications," that POD and sizing performance data in the Appendix H technique qualification ETSS sheets may not necessarily be suitable for use in tube integrity assessments. The guidelines fail to note that the same is true with respect to analyst performance in the Appendix G qualification. The guidelines fail to identify under what circumstances the Appendix H and G data might not be suitable. Nor do the guidelines identify what are the needed attributes of a performance demonstration in order to sufficiently quantify the NDE POD and sizing uncertainties to support site-specific tube integrity assessments. The staff believes that such guidance should be provided. (Needed attributes of performance demonstration to quantify NDE system uncertainty are identified in the staff's August 2, 2001 letter.)

The EPRI in situ test guidelines, Sections 4.2 and B.2.2.H, state that prior in situ pressure test results can be used to characterize NDE sizing uncertainties. No guidance for such an approach is provided. A rigorous approach for doing this is not self evident; therefore, the staff believes that this guideline is pre-mature.

Under the EPRI in situ test guidelines, each indication is assessed relative to screening criteria. The indication is in situ tested if the screening criteria are exceeded. The guidelines for developing these screening criteria are only intended to ensure that each indication meets the applicable performance criteria with a probability of 0.9. These guidelines ignore the performance standard in Section 5.2 of the EPRI tube integrity assessment guidelines which is intended to ensure a high likelihood that all tube satisfy the applicable performance criteria. Given several indications each satisfying the performance criteria with a probability of 0.9, there may be, nevertheless, a relatively high probability that one or more these indications actually doesn't meet the performance criteria (see earlier illustration of this point).

In general, the screening criteria should be developed making conservative bounding assumptions to account for all significant uncertainties. Alternatively, if statistical methods are being employed, all indications found to contribute unacceptably to the probability of one or more tubes not meeting the performance criteria should be in situ pressure tested.

The staff does have concerns about the interpretation of "TUBE 2 - In-Situ Testing Screening Criteria." We believe this interpretation adds little to the reference guideline and is not sufficient to prevent users from mis-applying the guidelines when selecting tubes for in-situ pressure testing. The first paragraph of the interpretation identifies material property and NDE measurement uncertainties as the key parameters which need to be evaluated for purposes of setting threshold screening values for in-situ pressure testing. The second paragraph is intended to summarize the first paragraph, but identifies additional parameters not identified in the first paragraph which should be evaluated. In addition, examples given in the first paragraph of the treatment of these parameter uncertainties only address material property uncertainties. Examples should be included to address other relevant parameters, particularly NDE measurement uncertainty.

The staff acknowledges that the EPRI Review Board interpretations are intended simply as interpretations and not as a device for modifying or supplementing the guidelines. However, the staff believes that the intent of the guidelines has always been that the in-situ test screening criteria should include appropriate allowance for NDE flaw size measurement error. The aforementioned interpretation responds to an inquiry which reflected some confusion on this point. We think it is appropriate that an interpretation include sufficient information such as to fully clarify the original intent of the guidelines.

Apart from the interpretation itself, the staff continues to believe that the in-situ test guidelines and the tube integrity assessment guidelines lack specificity over how to account for NDE sizing uncertainty, particularly in situations where NDE qualification data does not include sizing performance data for total NDE systems (technique plus personnel) for a statistically significant set of specimens containing flaws which are representative of those at the site in terms of flaw morphology, tube geometry, signal response, and signal to noise ratio. We recommend the next revision of the guidelines include such specificity to ensure appropriate treatment of NDE sizing uncertainty in developing in-situ pressure test screening criteria and when performing tube integrity assessments.

The staff also acknowledges that the interim guidance to test all indications exceeding the screening criteria in the SGMP letter dated October 13, 2000 mitigates the staff's concern that the tubes with indications in excess of the screening criteria might not be tested without sufficient basis. However, unless this criterion is carried forward to the next revision of the guideline, the staff believes that the above concerns relating to the guideline and the NEI Review Board Interpretation need to be addressed.

In summary, the staff believes that improved guidance is needed for consideration of NDE measurement error for purposes of determining appropriate screening criteria for in situ pressure testing. If the interim criterion for testing all tubes exceeding the screening criterion is not to be carried forward to the next revision of the ISPT guidelines, then the guidelines for selecting which tubes exceeding the screening criteria need to be tested also need to be improved. The staff considers the need for improved guidance for characterizing NDE sizing uncertainty to be a high priority issue since adequate treatment of the uncertainties is essential to ensuring that appropriate in situ screening criteria are implemented and, thus, the conservatism of condition monitoring. In addition, this issue directly relates to the effectiveness of condition monitoring in identifying conditions adverse to quality in accordance with 10 CFR 50, Appendix B, Criterion 16. The staff plans to pursue this issue with industry, but does not consider this issue to be an immediate safety concern. The risk implications associated with this issue are limited by virtue of the periodic inspections required by the current technical specifications. The NEI SG generic change package is not expected to increase risk associated with this issue unless the licensee is planning to operate for a longer inspection interval than is currently permitted by the technical specifications. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis. The staff considers this issue to still be open.

Additional Industry Comments (8/9/02):

There are three active ad hoc committees addressing the staff's concerns, the In Situ Guidelines Revision Committee, the Integrity Assessment Revision Committee, and the Integrity Ad Hoc Committee. All interim guidance issued by the SGMP will be incorporated into the next revision of the guidelines. The In Situ and Integrity Assessment Guidelines Committees have a goal to ensure consistency between the guidelines. The Integrity Ad Hoc is developing processes and procedures for improving the EPRI ETSS data sets, developing system uncertainties, and displaying adequate information on the ETSSs to support assessments.

Issue LL 2h from Lessons Learned Report:

Licensees should use a conservative approach to screening tubes for in situ pressure testing, and should include tubes with new forms of degradation even if the screening threshold is not met. Industry should modify guidelines on screening criteria to include new forms of degradation.

Initial Industry Response (8/1/01):

See response for RIS-6 above.

Industry Response (NRC Summary):

Existing industry guidance is adequate.

Industry response to Issue 6 of RIS-2000-22 also addresses "...should use a conservative approach..." The response below addresses "new forms of degradation."

Industry has acknowledged (see industry response to LL2I) that some additional guidance is required to address the actions to be taken upon the discovery of new degradation. With respect to candidate selection for in situ pressure testing, it is not appropriate to automatically require in situ testing of new degradation. If the morphology can be adequately characterized and NDE values technically supported, condition monitoring can be performed without the necessity of in situ pressure testing if the screening criteria are met.

Immediate actions: None

Actions to be tracked by SGMP: Guidance on selection of in-situ pressure test candidates will be strengthened in the forthcoming Revision 2 of the ISPT guidelines to incorporate lessons learned. Thus, issue LL 2h is considered closed.

Staff Evaluation:

The staff agrees that with an adequate technical basis to support the assumed NDE flaw size measurement error performance for new forms of degradation, that in situ testing of tubes satisfying the performance criteria should not necessarily be mandated. The staff considers this issue to be closed.

Issue 7 from RIS 2000-22:

Rigorous analyses of the results of in situ pressure tests that are terminated when leakage exceeds the capacity of the test system.

Initial Industry Response (4/26/01):

RIS &: Assessment of Test Results:

Issue 7 is the NRC's concern that ANO 2 terminated a pressure test without determining whether the burst pressure was actually higher than the maximum pressure reached during the test. The test was terminated when leakage exceeded the capacity of the test equipment. The licensee did not repeat the test with a bladder.

Industry response: Existing Guidance is adequate

As indicated in the Staff position with respect to Issue 7, the EPRI *In Situ Pressure Test Guidelines* provide information regarding the assessment of test results and recommendations regarding test actions if leakage is observed.

As indicated in Section 1 of the EPRI Guideline, the guidance provided is experienced-based, in that the protocol and expected output are considered achievable with existing technology. It is important to highlight this consideration. Admittedly, it would be desirable to utilize equipment and processes that have capabilities similar to laboratory programs. However, tooling (e.g., access, delivery, low flow rates) and steam generator configurations (e.g., u-bends, support structures, tubesheets) often limit the conclusive nature of some tests. It is in these cases that additional information, analysis and engineering judgement are needed to assist in determining if the tube satisfies integrity performance criteria.

Specific guidance is provided by EPRI with respect to leakage conditions during the conduct of a proof test. This guidance applies to test conditions following demonstration of accident leakage levels. The guidance is provided in Steps 5.2.9 and 5.2.10 of the In Situ Pressure Test Guidelines and reads:

5.2.9 Increase the pressure differential to the required level to verify that the burst pressure at operating temperature is in excess of the limiting loading condition on the tube as specified in NEI 97-06. If substantial leakage was observed at the limiting accident pressure differential or if eddy current inspection results indicate a near through-wall condition, then pressure testing for structural margin verification may require the use of a sealing bladder since the level of leakage may not allow for the full pressurization test.

5.2.10 If structural margin testing can not be performed without a sealing bladder (due to defect location and/or tooling limitations), measure the leak rate at the maximum test pressure and optionally repeat a

leak rate measurement at limiting accident pressure differential as the pressure is decreased. These measurements with an analytical evaluation may provide a basis for structural integrity by comparing the leakage values with that predicted for the NDE characterized flaw.

Further reinforcement of this recommendation, regarding the use of sealing bladders was provided in an EPRI letter issued October 13, 2000, *Steam Generator Management Program (SGMP) Interim Guidelines on the In Situ Pressure Testing of Steam Generator Tubes.*

Section 5.3 of the EPRI Guideline also provides for Post-Test actions to assist in confirming test results. The actions in Section 5.3 are considered valuable if the test objectives are not met or if the test was suspended prematurely due to tooling limitations. Actions include post-test ECT and visual examinations (if required). The purpose of these exams is to provide documented evidence of flaw changes. The guidelines do not suggest as indicated in the RIS that these post exams provide information regarding “margin against burst”, but rather that these exams can be useful in determining if burst[5] (as defined in the EPRI *Steam Generator Integrity Assessment Guidelines*) or pop-through has occurred. It should be noted, that to provide further assurance of flaw stability and verification that burst has not occurred, the interim guidance of the aforementioned EPRI letter requires a minimum hold time of two (2) minutes at 3NODP. Again, it is recommended that a sealing bladder be utilized when possible. However, in cases were bladders cannot be used, structural integrity can still be demonstrated if constant pressure can be maintained for the required hold time and the flaw is subsequently verified not to have exhibited burst failure characteristics by ECT profiling and/or visual exam.

Section 7.0, *Data Analysis*, also provides some guidance for the interpretation of inconclusive test results. The information is experience-based and is considered a virtue of necessity when access to the flaws either by further testing or tube removal is not available (e.g., u-bends, horizontal runs, support interference).

As such, the approaches identified in Section 7 are intended to assist in assessing or reducing NDE uncertainty and possibly providing information regarding structural capability. In the example cited, the leakage test results (taken at multiple levels) were used to correlate flaw leakage characteristics with NDE results in an effort to more accurately describe the physical characteristics of the flaw. This information, dependent on the robustness of the correlation, may be used to predict the structural capability of the flaw. Although, as the Staff indicated, predicted leak rates are at times not consistent with leak rates from actual flaws, the strength of the approach presented in the EPRI guideline is the correlation of multiple test points with the NDE presentation of the flaw. Correlation of multiple points tends to blend the

5 Burst is defined as the gross structural failure of the tube wall. The condition typically corresponds to the unstable opening displacement (e.g., opening area increases in response to constant pressure) accompanied by the ductile (plastic) tearing of the tube material at the ends of the degradation.

uncertainties caused by crack tortuosity and small ligament failures and can provide better information in defining the physical characteristics of the crack (e.g., throughwall crack length). As such, industry disagrees that the approach leads to nonconservative results, but recognizes that each test must be evaluated based on the specific conditions and circumstances. It should be noted that the cited example was included in the guideline as it was previously accepted by the NRC Staff.

Immediate industry actions:

None

Future actions to be tracked by SGMP:

None

Resolution status:

Industry Response (NRC Summary):

Adequate industry guidance has been issued to address this issue.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

The industry response states that the staff's concern stems from termination of a pressure test at ANO-2 without determining whether the burst pressure was actually higher than the maximum pressure reached during the test. The staff's concern was actually different from this. The licensee did in fact perform an assessment to demonstrate that the burst pressure was both higher than the maximum pressure reached during the test and higher than the 3 delta p performance criterion. The staff's concern was that the licensee's assessment was not performed in a rigorous manner. Further, the staff concluded that the tube was actually at the point of incipient burst at the time the test was terminated.

The industry response takes issue with a statement in the RIS that the EPRI in situ test guidelines suggest that margin against burst can be verified by visual or eddy current examination. The industry states that the guidelines only intend that these examinations can be useful in determining if burst or pop-through has occurred. The staff notes that if this is actually the intent of the guidelines, then this should be stated in the guidelines. The staff's characterization of the guidelines is almost a verbatim quote. Section 7.1 of the guideline states:

> "If leakage is observed at the proof pressure or prevents attainment of the proof pressure, and sealing bladders are not available due to location or tooling

> limitations, **structural margin against burst may be verified via visual or ECT examination** or by extrapolation of the leakage data."

The industry response notes that the SGMP interim guidelines on in situ testing, dated October 13, 2000, requires a minimum hold time of two minutes at 3 delta p to provide further assurance of flaw stability and verification that burst has not occurred. The staff believes this recommendation to be entirely appropriate. The difficulty is, however, that Section 7 provides guidance for alternative methods for verifying structural margin in cases of an incomplete pressure test (due to leakage). The staff's paper, "Technical Issues/EPRI Guideline Documents," (provided as a separate attachment) provides extensive comments on these guidelines. These comments expand on the discussion in the RIS that the guidelines may lead to non-conservative assessments of incomplete test results in terms of burst margins associated with the flaw.

In summary, the staff believes that the EPRI in situ test guidelines may be non-conservative in some cases relative to this issue. The staff considers this to be an open and high priority issue since a non-conservative assessment can undermine the effectiveness of condition monitoring in identifying conditions adverse to quality in accordance with 10 CFR 50, Appendix B, Criterion 16. The staff plans to pursue this issue with industry and is considering having RES do some confirmatory testing with respect to the industry position. The staff does not consider this issue to be an immediate safety concern. The staff believes that it will likely be aware of any in situ pressure tests that are terminated prematurely such that it will have the opportunity to discuss with the licensee it's findings relative to the test results. In addition, the NRC baseline inspection program is being revised to take note of such a situation should it arise, again allowing the staff to be aware of the basis for the licensee's dispositioning of the test results. The NEI SG generic change package is not expected to increase risk associated with this issue unless the licensee is planning to operate for a longer inspection interval than is currently permitted by the technical specifications. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

Interim guidance will be incorporated into the next revision of the In Situ Guidelines and Section 7, "Data Analysis" has been deleted from the draft revision. Actions for dispositioning flaws will be incorporated in the next revision of the Integrity Guidelines. The staff's concerns will be addressed during this committee's work.

Issue 8 from RIS 2000-22:

Laboratory and in situ pressure test procedures should utilize pressurization rates that do not influence burst pressure results.

Initial Industry Response (8/1/01):

RIS 8: Pressurization Rate

Issue 8 is from laboratory burst and leak tests performed to support ANO-2 licensees assessment of inconclusive in situ pressure test results. The tests showed that burst pressure was strongly affected by the pressurization rates used during the tests. This was an unexpected finding and could potentially have generic implications.

Industry position: Existing industry guidance is adequate.

Chairman letter to the SGMP, “Steam Generator Management Program Interim Guidelines on In Situ Pressure Testing of Steam Generator Tubes”, dated October 13, 2000, addressed the issue until further guidance is added to the EPRI In Situ Pressure Test Guidelines, R2. An Ad Hoc Committee is being formed to begin Revision 2 to this guideline. The October letter requires licensees to:

- Test all indications above screening criteria not just the worst five indications.
- A minimum hold time of two minutes is required to verify crack stability at conditions of normal operating, limiting accident, and 3ΔP differential pressure, regardless of pressurization rate.
- Intermediate hold pressures with the minimum two-minute hold times at approximately every 500 psig or less, above the limiting accident differential pressure should be used to approach the proof pressure required to meet the performance criteria. Select the intermediate pressures commensurate with the desired accuracy of the final pressure.
- Pressurization rates should be maintained less than 200 psi/sec, as averaged over the time interval to each hold point.
- If leakage develops, insert a sealing bladder prior to raising pressure, if possible, but not before demonstrating leakage integrity at the limiting accident condition.
- For cases where screening criteria applied to axial indications indicate a need for leak testing but not pressure proof testing, one should still perform a pressure proof test.

An investigation of this phenomenon was performed by the SGMP, EPRI Report 1001441, Effect of Pressurization Rate on Degraded Steam Generator Tubing Burst Pressure, April 2000. The report concluded that tests should be performed to determine if the apparent ramp rate effect was more a function of the differences in the way the fast and slow tests were conducted (i.e., slow tests were conducted without a bladder and foil reinforcement and fast tests were conducted with a bladder and foil reinforcement). This testing was conducted and the results indicate that the foil reinforcement was the cause of the difference in burst pressure for the slow and fast tests.

Immediate industry actions:

None

Future actions to be tracked by SGMP:

Rev 6 of the PWR Steam Generator Examination Guidelines will be provided to the NRC by January 2002

Resolution status:

Industry Response (NRC Summary):

Existing industry guidance is adequate.

This issue stems from laboratory burst and leakage tests performed to support Arkansas Nuclear One, Unit 2 (ANO-2) licensee's assessment of inconclusive in situ pressure test results. The laboratory results suggested that burst pressure was strongly influenced by the pressurization rates used during the tests. This was an unexpected finding with potential generic implications.

An investigation of this phenomenon was performed by the SGMP and documented in EPRI report 1001441, "Effect of Pressurization Rate on Degraded Steam Generator Burst Pressure," April 2000. Subsequent testing indicates that foil reinforcement was the cause of the difference in burst pressure for the slow and fast tests of the ANO-2 test specimens. **[Industry should update this information to reflect more recent developments.]**

An ad hoc committee for the SGMP is being formed to prepare Revision 2 of the EPRI in situ pressure test guidelines. In the meantime, the SGMP issued interim guidelines on October 13, 2000 for in situ pressure testing of SG tubes. The interim guidelines which relate specifically to pressurization rate include:

- implement a minimum hold time of 2 minutes to verify crack stability at normal operating, limiting accident, and 3 delta P differential pressure, regardless of pressurization rate.
- implement intermediate hold pressures with the minimum 2 minute hold times at at least 500 psi increments when elevating pressure above the limiting accident pressure to the 3 delta P or proof pressure. The proof pressure must also be

held for 2 minutes.
- implement pressurization rates not exceeding 200 psi/sec.

Immediate industry actions: None

Future industry actions to be tracked by the SGMP: Revision 6 of the PWR Steam Generator Examination Guidelines will be provided to the NRC by January 2002. **[The staff assumes what the industry really means is that Revision 2 of the EPRI steam generator in situ pressure test guidelines will be provided to the NRC by ???]**

Staff Evaluation:

This issues has potential implications in two areas. One, it has implications for plants implementing alternate repair criteria (ARCs which rely on empirical burst and leak rate correlations which include data obtained with a high pressurization rate. Two, it has implications for in situ pressure test procedures.
In 1999, a whole tube *in situ* pressure test of a degraded steam generator tube was performed at Arkansas Nuclear One Unit 2 (ANO-2). During this test, the tube leaked in excess of the capacity of the system resulting in non-conclusive results regarding whether the tube met the performance criteria. Subsequent laboratory testing of electric discharged machined (EDM) flaws of a similar geometry suggested that the measured burst pressure of a specimen can be influenced by the rate of pressurization.

The industry reported their progress on the pressurization rate issue during a public meeting on September 28, 2000 (see meeting summary dated October, 12, 2000, "Summary of September 28, 2000, Meeting with the Nuclear Energy Institute (NEI) Regarding Steam Generator Tube Burst Integrity" - ADAMS Accession Number ML003760794).

Following the meeting, NEI summarized their findings to-date by submitting a letter dated November 8, 2000, "Interim Guidance for In Situ Pressure Testing" (ADAMS Accession Number ML003770571). In this letter and during the September 28th meeting, NEI provided the status of the industry's evaluation of the ANO-2 steam generator tube pressure testing results which included interim guidance on the conduct of in-situ pressure tests. This guidance included specifying a maximum pressurization rate of 200 pounds per square inch (psi) per sec, adding additional hold points during the conduct of the test, and specifying a minimum hold time of two minutes to verify crack stability.

In addition to providing guidance on in-situ pressure testing, the November 8, 2000, letter, also indicated the unexpected test results at ANO-2 relate to any crack, greater than the through-wall critical crack length, that contains crack segments greater than 90% through-wall, but that the absence of the rate effect at very slow rates of pressurization has not been specifically demonstrated for other defect morphologies. Nonetheless, they concluded there was no dependency on pressurization rate in any of the industry standard correlation data sets. Regarding these conclusions and observations, the NRC indicated it would be beneficial if the industry further clarified their basis in their report in light of the fact that the absence of the pressurization effect has not been specifically demonstrated for other defect morphologies indicating to the NRC staff that the potential exists for the correlations to be affected. At the September 28, 2000, meeting, the industry indicated it would consider doing some verification testing of their hypotheses regarding the necessary flaw morphology for observation of the pressurization effect.

During the September 28, 2000, meeting and subsequent to it (refer to NRC letter dated January 5, 2001, “Interim Guidance for In-Situ Pressure Testing Pertaining to Pressurization Rate”), the NRC staff indicated that the modifications to the in-situ pressure testing guidelines appeared appropriate until the issue was resolved. In addition, the NRC staff indicated it would be interested in hearing the outcome of any additional verification testing performed by the industry.

The industry published a report in April 2001 documenting their conclusions as of Fall 2000 (EPRI Report TR-1001441, “Effect of Pressurization Rate on Degraded Steam Generator Tubing”). This document was submitted to the NRC by the Tennessee Valley Authority (TVA) in support of their GL 95-05 submittal for Watts Bar (TVA letter dated August 22, 2001).

On April 26, 2001, the industry presented to the NRC staff additional testing results concerning the pressurization rate issue (refer to ML011410505). These results indicated to the industry that there is no pressurization rate effect, rather the effect is due to the reinforcing foil used during the tests. At the April 26, 2001 meeting, the industry indicated it was in the process of updating the industry study (EPRI TR-10001441) to include the latest test results. These latter test results were formally provided to the NRC by TVA letter dated August 22, 2001.

Whereas the industry’s effort were aimed at understanding the effect for all burst pressure databases, TVA’s effort were aimed at understanding whether the effect impacted the databases they proposed to use in support of their license amendment related to the implementation of the voltage based tube repair criteria discussed in Generic Letter 95-05. The NRC staff reviewed the information submitted by TVA to determine whether it was acceptable for TVA to implement GL 95-05. The more generic review is still on-going as discussed below.

The NRC approved the implementation of the GL 95-05 repair criteria for Watts Bar in a February 26, 2002, safety evaluation (ML020590277). In this safety evaluation, the NRC concluded that there was reasonable assurance that the 3/4-inch burst pressure database proposed by TVA was not significantly affected by tube pressurization rate and/or foil effect. However, the NRC indicated they were not concluding that there was no time dependent effect on burst pressure (e.g., pressurization rate effect) and/or there is no foil effect affecting the 3/4-inch diameter database; rather, the NRC believed the effects, if any, were small. The NRC staff also noted that future limitations on the pressurization rate of flaws (consistent with the industry’s interim guidance on the conduct of pressure tests) and additional research will provide additional insights on this phenomena.

By letter dated November 5, 2001, NEI provided an updated copy of their report, EPRI TR-1006252, “Effect of Pressurization Rate on Degraded Steam Generator Tubing Burst Pressure,” dated August 2001. This report indicates that the effects observed by ANO-2 were a result of the foil used during the testing rather than a pressurization rate effect. The NRC staff is in the process of reviewing the report. Some initial observations are provided below

The Type 14 testing did not include performing tests under a slow pressurization rate with a foil. The NRC staff believes this testing could provide insights for the generic evaluation of this issue on whether the presumed foil effect is dependent on the pressurization rate.

Preliminary testing by the Office of Nuclear Regulatory Research indicates there are time-dependent increase in leak rates in deep stress corrosion cracks under constant pressure. Such time-dependent behavior has not been observed in EDM notches. Limiting pressurization rates and inserting hold times may address this.

Issue is complex and appears to depend on flaw morphology - longer and deeper flaws of more concern.

As a result of the review to-date, the NRC has provided the following to the Office of Nuclear Regulatory Research:

“The industry and the NRC have investigated whether the measured burst pressure of a specimen is affected by the rate of pressurization. These investigations have led to non-conclusive results and have raised questions of whether other test conditions (e.g., foil, bladder) may affect the burst pressure of the specimen. A research program to thoroughly investigate whether pressurization rate or other testing parameters affect the measured burst pressure of specimens should be conducted. Factors to consider in this testing program include:

Notches may provide insights into the behavior of stress corrosion specimens; however, it is not clear whether something more complex is occurring in actual stress corrosion cracks that does not occur in notches. Tests should be performed to determine if this is occurring.

The industry test program indicated that small variations/deviations of notch profiles from one specimen to the next may affect conclusions regarding whether there is an effect and the magnitude of the effect. Testing should consider normalizing the data so as to eliminate this effect.

Evaluation should only be performed for test conditions that have routinely been used in the field (e.g., maximum pressurization rate of 2000 psi/sec, maximum foil thickness of x.x-inch, etc.)

If an effect does occur, guidelines/models to predict when it would be expected to occur and the magnitude of the effect should be developed. For example, assume there is a pressurization rate effect. Is the effect noticeable for 0.2-inch long flaws which are 90% through-wall? If so, what is the magnitude? The goal of this effort would be to determine what data points in various burst pressure databases are affected and by how much.

The industry has tested “type 14" specimens at fast and slow pressurization rates when a foil was present and at fast pressurization rates without a foil; however, they have not tested such specimens at slow pressurization rates without a foil. These tests should be considered. The prior tests indicated that there was no pressurization rate effect when a foil is not present.

Could other parameters other than those presently being investigated (e.g., pressurization rate, foil, bladder) affect the results. For example does instrument response time play a role for the range of pressurization rates?" 2002.]

Pending completion of this review, the staff believes this issue does not pose a significant safety issue. Application of the voltage based ODSCC ARC is limited to axial cracks confined to within the 3/4-in. thickness of the tube support plates (TSPs). The short length of the cracks addressed by the ARC mitigates any concern with respect to pressurization rate effects based on available evidence. The pressurization rate effect does not come into play from the standpoint of satisfying the 3 delta P criteria since the tubes are restrained against burst under normal operating conditions. In addition, the test specimens used to construct the correlations were leak tested under essentially quasi static conditions up to main steam line break (MSLB) pressure prior to installing a bladder and testing to burst at high pressurization rate. Thus, burst pressure data down around MSLB pressure should be relatively unaffected by pressurization rate. With respect to plants implementing the PWSCC ARC at dented TSP intersections, the plant technical specifications preclude licensees from using burst correlations which may potentially be affected by the pressurization rate effect.

The staff believes that the SGMP interim guidance on in situ pressure testing addresses several significant shortcomings in the existing revision (Revision 1) of the EPRI in situ pressure test guidelines. The two minute holds at intermediate test pressures leading up to and including the proof pressure, coupled with a pressurization rate less than 200 psi/sec will significantly reduce the potential for inconclusive in situ pressure test results such as occurred at ANO-2. The staff believes this guidance to be adequate for the interim period pending completion of the staff's review of aforementioned industry submittals.

In summary, the staff is continuing to evaluate the pressurization rate issue and, thus, this issue remains open. Before final conclusions can be reached, the industry needs to specifically identify the conditions under which different types of degradation mechanisms may be subject to a pressurization effect. In addition, industry may wish to provide comments on NRR's request to RES regarding needed testing. This issue does not pose a significant safety concern at this time for the reasons cited above. Nor does this issue impact the staff's review of the SG GLCP since the staff will still retain control of tube repair criteria and, in addition, the industry has appropriate interim guidance concerning in-situ pressure testing which the staff believes will effectively minimize any pressurization effect.

Additional Industry Comments (8/9/02):

The staff has reviewed the EPRI documents addressing the ramp rate issue as it applies to two alternate repair criteria: Generic Letter 95-05 ARC and PWSCC at dented intersections. The staff concluded that the ramp rate did not affect the validity of the ODSCC database supporting Generic Letter 95-05 ARC and has imposed a ligament tearing leakage model for the PWSCC ARC. With alternate repair criteria resolved, the industry believes the interim guidance to be sufficient to resolve the ramp rate issue. The interim guidance will be incorporated into the next revision of the In Situ Guidelines.

Issue 9 from RIS 2000-22:

Use of a “fractional flaw” method or other similar methods for determining a beginning-of-cycle flaw distribution may lead to non-conservative results when used in conjunction with a POD parameter which varies as a function of flaw size or voltage.

Initial Industry Response (4/26/01):

RIS 9: Frctional Flaw Methodology:

As stated in RIS 2000-22, Issue 9 derives from the NRC Staff’s review (TER dated 10/10/2000) of ConEdison’s operational assessment to support the Indian Point-2 (IP2) restart following the SG tube failure event on February 15, 2000. In understanding the basis for the comment generated by the NRC, EPRI SGMP has reviewed the IP2 Operational Assessment, the Technical Evaluation Report (TER) issued by the NRC and the guidance provided in the EPRI Steam Generator Integrity Assessment Guideline (SGIAG), Revision 1. **It is industry’s position that the existing guidance is adequate.** Due to the complexity of this issue, discussions regarding the use of POD in operational assessment and a detailed summary of the methodology applied at IP2 are provided for informational purposes in support of the industry response.

Background

In performing a steam generator operational assessment, the evaluator must determine the frequency distribution of defects as a function of defect size projected to exist at the end of the operating cycle (EOC). The quantity and severity of the EOC defects are then assessed to determine if the applicable performance criteria have been satisfied. Depending on the nature of the utility’s plant specific repair criteria, there may be three (3) distinct groups of indications remaining in the steam generator following an inspection. The first group involves those indications found by inservice inspection that are permitted to remain in service prior to plant restart and that may continue to grow. Secondly, there are those indications that were not detected during the inspection but are assumed to exist based on the scope and limitations of the inservice inspection. Finally, there are those indications that initiate during the operating cycle and are therefore not accounted for by the inspection process. The NRC Staff concerns, identified in RIS Issue 9, impact the second group of undetected defects and the methods used to define the frequency distribution of this population of defects in the steam generator at plant restart following steam generator inspections.

In the operational assessment process, the method of determining the size and distribution of these “hidden” or undetected defects is a core process in the evaluation model. As such, the evaluation requires the ability to analytically describe the inspection process, and its effect in defining the Beginning of Cycle (BOC) condition. After completion of an operating cycle, a steam generator that is experiencing degradation will have a number of tubes with defects of various sizes. An ideal NDE system would find and characterize the total defect population. In actuality, the inspection instead reveals an observed or detected defect population that is the result of a less than ideal screening process on the larger true/total defect population. Therefore, inspection simulation model generally considers the NDE system as a filter, which passes indications of various sizes with varying efficiency. This effect of splitting the true population into detected and undetected populations is depicted qualitatively in Figure 1.

To simulate this process, the NDE system detection performance is typically quantified by means of a probability function commonly referred to as the Probability of Detection (POD). In the EPRI SGIAG, POD is defined as the likelihood that a NDE system, consisting of both the technique and the analyst, will detect a flaw. The SGIAG further states, that the POD may be expressed as a function of the severity of degradation, which is consistent with NRC publication NUREG/CR-6227 *Performance Demonstration Tests for Eddy Current Inspection of Steam Generator Tubing*. The SGIAG states that POD may also be expressed as a fraction of the total population of flaws (irrespective of defect severity) that would be detected by the NDE system (e.g., POD = 0.6 per Generic Letter 95-05).

The SGIAG further states that the application of POD in defining BOC is similar regardless of the selected POD function/definition. That is, if there are N_{Ti} total indications present in the i^{th} depth range for which POD_i is the detection probability for the depth range, the number of detected indications $N_{Di} = N_{Ti} \bullet POD_i$ and the number of undetected indications $N_{UDi} = N_{Ti} - N_{Di} = N_{Di}/POD - N_{Di}$. When applied to a depth range of a single detected indication, $N_{UDi} = 1/POD – 1$, which was the approach applied in the IP2 analyses. The number of indications at the beginning of cycle, N_{BOC}, is the total indications minus the repaired indications, $N_{BOCi} = N_{Ti} – N_{Repi}$. When all detected indications are repaired, i.e., plug on detection, then:

$N_{BOCi} = N_{Ti} – N_{Repi} = N_{Ti} - N_{Di} = N_{UDi}$.

Using Figure 1 again, in the case of a constant POD, the two subpopulations (detected and undetected {BOC}) would be identically distributed with the relative numbers of defects determined by the POD value (e.g., 0.6). However as shown in Figure 1, for the case of the depth-dependent POD, the two subpopulations are no longer identically distributed. The increased POD at the higher defect depths results in a shift of the detected subpopulation to the right and the undetected subpopulation to the left. This is a valid depiction of the inspection process which does not arbitrarily introduce conservatism or non-conservatism.

IP2 Methodology

The approach utilized in support of Indian Point 2 and reviewed by the NRC is described in a Westinghouse/E-Mech report, *Indian Point-2 U-Bend PWSCC Cycle 14 Condition Monitoring and Cycle 15 Operational Assessment* dated May 30, 2000. In the IP2 Report, the BOC condition is defined via the application of an adjustment (1/POD – 1) to each indication detected in the EOC 14 inspection. This approach leads to either a fraction of an indication (in the case of large flaws where POD approaches unity) or more than one indication for each detected indication for smaller flaws. The NRC termed this POD methodology as a "fractional flaw" approach. As indicated, the application of this method to each defect of a given length measured in the inspection can result in fractional defects at the BOC. These defects are then assumed to have the same crack profiles of the detected defects to which the correction was applied. Profiles with fractional defects resulting from the correction are grouped together from highest to lowest depth until the sum of the fractional defects total unity. This sum defines a POD group for use in the tube burst pressure distribution calculation. A POD group is then analyzed as a single indication comprised of the distribution of crack profiles within the group, and the frequency of the profiles in the group are weighted by the fraction contribution of each profile to unity. It should be noted that the only reason to define a POD group and utilize a single indication definition for the POD group is a means to permit an analysis result in terms of the deterministic burst margin requirement of 3NODP. In the case of the IP2 assessment, the associated distribution of burst pressures for the single POD group permitted the evaluation at a specified confidence level against the burst margin requirement, while maintaining an evaluation process similar to GL 95-05. Alternatively, for a burst probability analysis (with probabilistic criterion similar to NRC approved ARCs), the POD group definition is not required and the analysis methods for POD adjustments are the same as approved by the NRC for GL 95-05 analyses.

Industry Response: Existing Guidance is adequate

In the NRC TER on IP2, the Staff stated that the use of a "fractional flaw" approach with a variable POD makes the operational assessment relatively insensitive to the size of the detected flaws and can lead to non-conservative results. The Staff based their position on IP2 EOC results from applied BOC depth profiles obtained from high frequency 800 kHz analyses and from mid-range 400 kHz analyzes in two operational assessment analyses using the same depth-dependent POD distribution. The following points were noted in the TER:

1) The high frequency sizing estimates for the just completed operating period (EOC_N) yielded deeper depth profiles and calculated burst pressures for the detected defects that were an average of about 18% lower than similar flaws sized with the mid-range probe.

2) The projected EOC_{N+1} results for the operational assessment using the high frequency ECT profiles compared to the results using mid-range ECT profiles had limiting indication burst pressures only about 3% lower and SLB burst probabilities that were about 13% higher.

3) The difference of 18% versus 3% in the EOC_N versus EOC_{N+1} burst pressures is principally the result of applying the same depth-dependent POD for both analyses.

The NRC Staff described this result as counter-intuitive and considers the IP2 results to be indicative of a non-conservative process. Conversely, it is industry's position that the use of fractional flaws or whole flaws in the analysis is an artifact of Monte Carlo sampling techniques and that the assessment process used in the IP2 analysis is consistent with EPRI guidance and is a technically appropriate modeling approach. This position does not consider the accuracy of the input variables used in the IP2 analysis. The basis for this industry position is as follows.

It is well documented in industry and regulatory literature, that when a POD distribution which increases with depth is applied to two different depth indications in an operational assessment, the indication with the larger depth has a higher POD and a smaller fraction of an indication is returned to service per N_{UDi} = 1/POD – 1, as described above. This corresponds to the smaller probability that there is an undetected indication of the same magnitude being in the steam generator. As indicated previously, this is a technically correct simulation of the inspection process that is appropriate for the operational assessment. It should be noted that this position is based on a correct and accurate characterization of the POD, and is separate from industry and Staff issues regarding data quality and performance demonstration. Given this premise, it can be explained that the results that the Staff considers counter-intuitive are, in reality, a specific detail of modeling assumptions used at IP2, given the available information (e.g., no credit for improved detection or sizing).

For example, the NRC position results from an assumption that a flaw distribution with deeper depths and lower burst pressures should result in lower EOC burst pressures than a second flaw distribution with more shallow depths. Industry concurs that this would likely be the expected result if the two detected flaw distributions with different depths were the results of two different EOC inspections. In that case, the cause of the deeper detected flaw distribution would likely be the result of larger growth rates, and thus the incorporation of the higher growth rates in the operational assessment would yield the more conservative EOC results expected given the same POD at the last inspection. Although this is a likely scenario, it is important to consider the influence of all the components of the evaluation. To illustrate this further, the cause of the deeper detected flaw distribution may not be due to a higher growth rate, but rather a poorer POD at the prior inspection. In this case, the corrective action (e.g., use of more sensitive probe) leading to an improved POD at the subsequent inspection and an improved BOC condition should be the desired response by the utility and the regulator. If the POD capability is correctly modeled, the operational assessment, in this case, should not be penalized by requiring the use of a constant POD in the analysis.

Consequently, in considering the evaluation process in the IP2 assessment, the results are not considered unreasonable given the constraints on the analysis. That is, if the POD is the **appropriate** distribution, and if the growth rates and NDE sizing uncertainties are the same for both flaw distributions, as was applied in the IP2 calculation, the deeper initial flaw distribution need not result in correspondingly significantly lower EOC burst pressures. The fact that the final EOC prediction yielded little difference can be illustrated conceptually by simply considering the frequency weighted average depth, i.e., the probability of being missed (one minus the probability of being detected) times the depth. Larger depths are multiplied by a smaller probability of being missed and smaller depths are multiplied by a larger probability of being missed. For example, the product of a 75% flaw depth and a 25% probability of being missed is the same as the product of a 25% flaw depth and a 75% probability of being missed. However, use of a constant POD for both inspections versus a depth dependent POD in this case would generate over-conservatism when the depth dependent POD is adequately developed and appropriately models the capability of the NDE system.

In summary, the use of a variable POD (dependent upon depth, area, or volts) that results in fractional indications for the undetected population is technically correct and appropriate for operational assessments. The appropriateness of this POD technique is not dependent upon specific Monte Carlo applications, wherein the undetected indications can be evaluated as fractional indications for each SG sample or as whole indications occurring in SG samples at the fractional frequency. The application of variable PODs correctly simulates the inspection process and does not arbitrarily introduce conservatism or non-conservatism in an operational assessment. Interpretation of the IP2 example as a non-conservative basis for requiring a constant POD introduces arbitrary conservatism that inhibits benchmarking and the causal assessment of finding larger indications in an inspection such as larger growth rates or a poor prior cycle POD.

Based on the results of this review, EPRI SGMP concludes that no immediate changes are required to the SGIAG with respect to how POD is defined (e.g., variable or constant) or applied in determining BOC conditions in support of operational assessments.

Immediate Industry Actions:
None

Future Actions to be tracked By SGMP:
None

Resolution Status

Industry Response (NRC Summary):

The fractional flaw approach is technically valid irrespective of whether a constant or variable POD assumption is employed

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

This is a complex issue as acknowledged by the industry in their response. The staff is reviewing the industry response and has not yet reached a conclusion regarding whether this issue is satisfactorily resolved. The staff considers this issue to still be open.

The staff considers this to be a high priority issue since the methodology is being used today for operational assessment. In addition, resolution of this issue is necessary since operational assessment will constitute an important element of the technical justification should licensees desire extended inspection intervals (relative to current technical specifications) for plants with active SG tube degradation. The NEI SG generic change package is not expected to increase risk associated with this issue unless the licensee is planning to operate for a longer inspection interval than is currently permitted by the technical specifications. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

NRC is requested to complete its review of this item.

Issue 10 from RIS 2000-22 and LL 2m from Lessons Learned Report:

Benchmarking operational assessment methodologies against actual operating experience to ensure realistic results.

Initial Industry Response (4/26/01):

RIS 10, LL 2m: Benchmarking

Adequate industry guidance has been issued to address this issue.

During the NRC's review of ANO-2 licensee's operational assessment, it was noted that more and bigger flaws were found during the November 1999 mid cycle than were predicted by the previous operational assessment. The licensee was unable to convincingly benchmark its operational assessment methodology; however, used the same methodology to justify the next operating interval.

Industry position: Existing industry guidance adequate.

The Steam Generator Integrity Assessment Guidelines, Revision 1 addresses benchmarking in the following sections:

Section 8.1 states "If condition monitoring indicates a significant difference between what is found in the steam generators and the operational assessment prediction from the previous outage, analyses must be performed to identify the reason for the difference. If necessary, values of variables used in the operational assessment methodology should by corrected for prediction of the next operating interval."

Section 1, Figure 1-1 graphically depicts the actions taken during tube integrity assessments. One of the key aspects is noted as validating the operational assessment was accurate using condition monitoring results.

Section 6.5 requires the licensee to benchmark whenever possible growth rate distributions by "comparing the predicted results to as-found EOC distributions". Section 9.6 requires methodologies for projecting the BOC distribution of indications to be "assessed versus the actual distribution found at the next inspection."

Immediate actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry Response (NRC Summary):

Adequate industry guidance has been issued to address this issue.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

Staff acknowledges industry's general guidance to this effect. However, this guidance is not of sufficient detail to guide users from repeating inappropriate benchmarking assessments performed in the past such as the example cited in the RIS.

The staff considers this issue to be open and relatively high priority since it is essential to ensuring the conservatism of the operational assessment. In addition, resolution of this issue is necessary since operational assessment will constitute an important element of the technical justification should licensees desire extended inspection intervals (relative to current technical specifications) for plants with active SG tube degradation. The NEI SG generic change package is not expected to increase risk associated with this issue unless the licensee is planning to operate for a longer inspection interval than is currently permitted by the technical specifications. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis.

Additional Industry Comments (8/9/02):

Benchmarking operational assessment predictions to condition monitoring results will be strengthened in the next revision of the Integrity Guidelines.

Issue LL 2m from Lessons Learned Report:

The EPRI Steam Generator Integrity Assessment Guidelines should be revised to address that care should be taken in relying on predictive models for PWSCC, and that licensees should maintain an aggressive approach in evaluating inconsistencies with predicted and observed degradation behavior.

The NRC Lesson Learned Task Group found that the predictive models used by IP2 did not accurately reflect the findings of the inspection in 1997 and the subsequent inspection performed in 2000. The Staff believes that licensees should maintain a more questioning attitude and should aggressively seek to understand inspection findings that differ from predictions.

Initial Industry Response (8/1/01):

LL 2m: Predictive Models for PWSCC

Industry position: Existing industry guidance is adequate.

This response has been developed based on the following premises:

1. The issue is related to predictive modeling for all forms of degradation and should not be limited to PWSCC.
2. The discussion will be limited to condition monitoring and operational assessment. The fact that IP2 had taken measures to conduct a defect specific inspection of the Row 2 U-bends in 1997 is indicative that the process of degradation assessment was conducted appropriately (Per Revision 5 of the EPRI *PWR Steam Generator Examination Guidelines*) with respect to inspecting a critical area.
3. This response is not related to the degradation assessment issues identified in RIS Issues 1 and 2 and LL Issues 2e, 2f, and 2k.
4. The guidance identified in this response was not available to IP2 in 1997.

The issues identified by the NRC Task Group are addressed in provisions contained within the EPRI Steam Generator Integrity Assessment (SGIA) Guideline and a subsequent letter issued by EPRI SGMP. For example, the need to maintain a conservative approach regarding the use of industry data to support defect growth rates is provided in Section 6.5 of the SGIA Guideline. The guideline states: "Where plant specific data for a given degradation mechanism is scarce, it is acceptable to supplement plant specific growth data with applicable data from other units. This data should be consistent and conservative with respect to available plant specific data regarding average and bounding growth rates. Other considerations concerning the applicability of data from other plants include similarities in microstructure, primary and secondary chemistries, crevice chemistry, thermal and hydraulic environment, operating temperature, level of denting and relevant design features (e.g., residual stress levels associated with tube expansions and u-bends, sleeve designs, etc)."

With respect to inspection findings that are different than predicted, Section 8.1 of the SGIA Guideline states: "If condition monitoring indicates a significant difference between what is found in the steam generator and the operational assessment prediction from the previous outage, analysis must be performed to identify the reason for the difference. If necessary, values of variables used in the operational assessment methodology should be corrected for prediction of the next operating interval."

Finally, a letter issued by EPRI SGMP (Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues dated September 29, 2000) emphasized the need for conservative decision making. The letter states: "Arbitrary assumptions on growth rate, intended to substitute for lack of data, may prove inaccurate and non-conservative and must be avoided. Additionally, consideration should be given to potential initiators or accelerators of degradation, such as induced stresses from tube support denting, to accurately anticipate degradation."

The excerpts indicate that industry guidance in this area has, in fact, been provided. Industry does not believe that additional generic guidance or specific guidance with respect to PWSCC is required.

Immediate actions:

None

Actions to be tracked by SGMP:

None

Resolution status:

Industry Response (NRC Summary):

Existing industry guidance is adequate.

This response has been developed based on the following premises:

1. The issue is related to predictive modeling for all forms of degradation and should not be limited to PWSCC.
2. The discussion will be limited to condition monitoring and operational assessment. The fact that IP2 had taken measures to conduct a defect specific inspection of the Row 2 U-bends in 1997 is indicative that the process of degradation assessment

was conducted appropriately (Per Revision 5 of the EPRI *PWR Steam Generator Examination Guidelines*) with respect to inspecting a critical area.

3. This response is not related to the degradation assessment issues identified in RIS Issues 1 and 2 and LL Issues 2e, 2f, and 2k.
4. The guidance identified in this response was not available to IP2 in 1997.

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The excerpts indicate that industry guidance in this area has, in fact, been provided. Industry does not believe that additional generic guidance or specific guidance with respect to PWSCC is required.

Additional Industry Comments (8/9/02):

The staff evaluation of this response is requested.

Issue 5 from RIS 2000-22:

Site-specific qualifications of generically qualified techniques ensuring an application is consistent with site-specific conditions and that appropriate NDE performance capabilities are considered in operational assessments (e.g., POD of flaws and flaw size measurement error).

Issue LL 2i from Lessons Learned Report:

Industry Guidelines should caution licensees not to rely to heavily on assessments based on sizing techniques that are not qualified.

In reviewing this item, the industry identified the need for some corrections to the lessons learned report. For example, the report indicates that Tube R2C74 was sized as being less than 40% in maximum depth and the tube would not be expected to leak during in situ testing. Measurements taken with the 800 kHz plus point indicated an "average depth" of less than 40% (39.4). Maximum depth measurements varied between 53 and 85%. The 85% value would have easily satisfied the In Situ Screening Criteria for leakage. It should also be noted that the IP2 Operational Assessment stated that this flaw had the lowest signal to noise data and that data was distorted due to apparent probe slippage. As will be noted in this response, guidance is provided that should point users to considering such flaws for further testing.

Initial Industry response (4/26/01):

RIS 5, LL 2i: POD and Sizing Accuracy

In reviewing this item, the industry identified the need for some corrections to the lessons learned report. For example, the report indicates that Tube R2C74 was sized as being less than 40% in maximum depth and the tube would not be expected to leak during in situ testing. Measurements taken with the 800 kHz plus point indicated an "average depth" of less than 40% (39.4). Maximum depth measurements varied between 53 and 85%. The 85% value would have easily satisfied the In Situ Screening Criteria for leakage. It should also be noted that the IP2 Operational Assessment stated that this flaw had the lowest signal to noise data and that data was distorted due to apparent probe slippage. As will be noted in this response, guidance is provided that should point users to considering such flaws for further testing.

Industry response: Existing Guidance is adequate

The EPRI *Steam Generator In Situ Pressure Test Guidelines* make several recommendations with regard to flaws for which sizing capability is not characterized. Section 4.2 of the guideline states that functional knowledge of NDE uncertainty is required. If sizing capability cannot be adequately characterized or bounded with prior pressure test results, the utility should consider testing a minimum of five indications in an effort to develop an appropriate technical basis for future screening. In Section 4.3, the guideline states that direction be given to the ECT Resolution Analyst to identify tubes that may be severely degraded despite not exceeding established screening criteria. This section cites, as an example, tubes with distorted signals from extraneous causes that could mask a flaw that exceeds NDE threshold values. Section 5.1.3 states further, that for questionable defect signals, consideration should be given to having the data obtained by conventional and supplemental NDE be evaluated by specialists in addition to the evaluation conducted by the production analyst.

The EPRI *Steam Generator Integrity Assessment Guidelines* (SGIAG) also emphasizes the need to characterize and account for NDE sizing uncertainty. It should be emphasized that the EPRI *Steam Generator Examination Guidelines* do not specify acceptance standards for "qualified sizing." The EPRI Appendix H ETSS sheets provide sizing performance statistics based on the sizing data set. The term "qualified" is only used in Section 4.6 of the SGIAG, and is defined as a technique that has sufficient information to describe the deviation from measured to true flaw size.

The SGIAG further states that although the protocol in Appendix H is considered reasonable, the values in the ETSS sheets should be evaluated for their suitability to integrity assessment. The SGIAG states that technique performance should be demonstrated by a correlation coefficient that establishes with 95% confidence that a correlation does statistically exist between the measured and true flaw size. If the correlation coefficient is less than the standard specified, a technical justification must be provided for using the data.

Information has also been provided in EPRI SGMP Letter, *Steam Generator Management Program (SGMP) Information Letter Concerning Lessons Learned from Review of Recent Steam Generator Related Issues*, dated September 29, 2000. The letter makes several recommendations with regard for the need to make adjustments to sizing parameters in cases were data quality impacts flaw evaluation and recommends that in situations of relatively difficult flaw evaluation with large uncertainty, that supplemental NDE techniques and specialized data review be considered.

Immediate industry actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry response (NRC Summary):

Existing Guidance is adequate.

The EPRI *Steam Generator In Situ Pressure Test Guidelines* make several recommendations with regard to flaws for which sizing capability is not characterized. Section 4.2 of the guideline states that functional knowledge of NDE uncertainty is required. If sizing capability cannot be adequately characterized or bounded with prior pressure test results, the utility should consider testing a minimum of five indications in an effort to develop an appropriate technical basis for future screening. In Section 4.3, the guideline states that direction be given to the ECT Resolution Analyst to identify tubes that may be severely degraded despite not exceeding established screening criteria. This section cites, as an example, tubes with distorted signals from extraneous causes that could mask a flaw that exceeds NDE threshold values. Section 5.1.3 states further, that for questionable defect signals, consideration should be given to having the data obtained by conventional and supplemental NDE be evaluated by specialists in addition to the evaluation conducted by the production analyst.

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Staff Evaluation:

The industry response does not appear to be entirely consistent with the SGMP information letter dated September 29, 2000. This letter acknowledges outstanding issues pertaining to characterization of NDE performance and states that the industry is reviewing the need for addition guidance in this area. This acknowledgment is made in the context of a POD discussion, but the issues noted apply equally to NDE sizing performance.

The industry response states that some facts cited in the lessons learned report are incorrect; specifically, the maximum crack depth cited for R2C74 (<40%) and the assertion that the tube would not have been expected to leak during in situ pressure testing. (R2C74 at Indian Point 2 exhibited a u-bend indication and developed leakage during in situ testing at 4800 psi.) The industry response states that maximum depth measurement varied between 53 and 85% and would have exceeded the in situ leakage test screening criteria necessitating a leakage test. On the basis of information provided formally to the NRC staff to support ConEd’s request to restart Indian Point 2, the staff believes that the cited information in the lessons learned report is correct. Table 3-5 and Figure C.1-11 of ConEd's CMOA report dated June 2, 2000 report show a maximum crack depth of 38% as determined at 400 KHz and 53% as determined at 800 KHz. ConEd and their contractor, Westinghouse, considered the 400 KHz depth measurements to be the most reliable and, thus, used these measurements in the reference CMOA assessment. However, even the 53% maximum depth measurement at 800 KHz is much less than the screening criteria necessitating a leakage test.

The industry response cites a number of guideline provisions for dealing with situations where sizing capability is not characterized. Detailed staff comments concerning these guidelines are contained in a separate attachment entitled "Technical Issues/EPRI Guideline Documents." In summary, the staff finds that the industry guidelines do not provide complete or consistent guidance on how to characterize sizing uncertainty. The staff believes that a site applicable performance demonstration of the NDE system is needed to establish sizing uncertainty. The white paper identifies key elements of such a performance demonstration. The white paper also comments on the industry guidance concerning the actions to be taken when sizing uncertainty is not characterized.

The staff considers the need for improved guidance for characterizing NDE sizing uncertainty to be a high priority issue since adequate treatment of the uncertainties is essential to ensuring the conservatism of condition monitoring and operational assessments. In addition, this issue directly relates to the effectiveness of condition monitoring in identifying conditions adverse to quality in accordance with 10 CFR 50, Appendix B, Criterion 16. The staff plans to pursue this issue with industry, but does not consider this issue to be an immediate safety concern. The risk implications associated with this issue are limited by virtue of the periodic inspections required by the current technical specifications. The NEI SG generic change package is not expected to increase risk associated with this issue unless the licensee is planning to operate for a longer inspection interval than is currently permitted by the technical specifications. This issue should not impact the staff's review of the generic change package provided the staff can be assured that longer inspection intervals will not be implemented without an adequate technical basis. The staff considers this issue to still be open.

Additional Industry Comments (8/9/02):

There are three active ad hoc committees addressing the staff's concerns. The In Situ Guidelines Revision Committee, the Integrity Assessment Revision Committee, and the Integrity Ad Hoc Committee. All interim guidance issued by the SGMP will be incorporated into the next revision of the guidelines. The In Situ and Integrity Assessment Guidelines Committees have a goal to ensure consistency between the guidelines. The current draft In Situ Guidelines have separate requirements for "techniques with quantified sizing" and techniques with no quantified sizing". The Integrity Ad Hoc is developing processes and procedures for improving the EPRI ETSS data sets, developing system uncertainties, and displaying adequate information on the ETSSs to support assessments.

Issue LL 2j from Lessons Learned Report:

Licensees should consider the effect of the threshold of detection and sizing accuracy on the growth rate assumptions.

Initial Industry Response (4/26/01):

LL 2J: Growth Rates

Adequate industry guidance has been issued to address this issue.

Report Reference: Section 6.2.4, #4.

An important aspect of an accurate Condition Monitoring and Operational Assessment is how uncertainties, threshold of detection, sizing accuracy, crack growth rate estimations, and probability of detection are considered. NRC's position is that licensees should consider the effect of the threshold of detection and sizing accuracy on the growth rate assumptions.

IP2 growth rates were based on looking back at the 1997 data for precursors to the indications found in 2000, and evaluating the change in voltages and phase angles. This task was complicated by the noisy data and the fact that the high frequency probe was not used in 1997 (had to compare the 1997 data at 400 kHz, which was noisier data that the 800 kHz high frequency data). Because none of the techniques used are qualified for sizing, reasonable estimates of error must be assigned to bound the expected growth rates calculated from the flaw sizes. Detection thresholds could be in excess of 50%, which reduces the amount of flaw data available to predict growth rates.

Industry position: Industry guidance is adequate.

Steam Generator Integrity Assessment Guidelines: Revision 1, TR-107621-R1; Chapter 4, NDE Techniques; Chapter 6, Degradation Growth Rate, provides guidance on determining growth rates. It discusses the use of a "reasonable, lower bound detection threshold" if the flaws were not detectable in the previous inspection. It also provides guidance on using the same analyst to evaluate the data from the two inspections and the need for at least 50 growth points in order to reduce uncertainties. If the 50 growth points are not available, the maximum observed growth rate should be used for the arithmetic or simplified statistical approach for the operational assessment.

Section 4.6, Sizing of NDE Indications, provides guidance on determination of the NDE sizing uncertainty. In order to size a degradation mechanism, the technique performance test data should have a correlation coefficient which establishes with a 95% confidence that a correlation does statistically exist between the measured size and what is considered the actual size. Then for condition monitoring and operational assessment, an NDE uncertainty at the 90% probability at a 50% confidence level is used.

The use of the NDE technique sizing uncertainty, coupled with the determination/use of growth rates determined in accordance with the guidance in Chapter 6, provide adequate guidance for operational assessments.

Immediate industry actions: None

Future actions to be tracked by SGMP: None

Resolution status:

Industry Response (NRC Summary):

Adequate industry guidance has been issued to address this issue.

No immediate industry actions are necessary.

No future action to be tracked by SGMP.

Staff Evaluation:

Sizing uncertainty can increase the uncertainty associated with apparent growth rates established from the NDE results. Treatment of these uncertainties tends to produce a more conservative operational assessment than would be the case if statistical techniques are used to extract sizing uncertainty from the apparent growth rate distribution to yield a “true” growth rate distribution. In this respect the EPRI SG Tube Integrity Assessment Guidelines are conservative.

The staff concurs that this issue is addressed in current guidelines. The staff considers this issue to be closed.

Issue LL 3a from Lessons Learned Report:

PWR technical specifications (or the regulatory framework currently being developed via the industry initiative) should ensure the technical requirements are strengthened to reflect the current knowledge of the SG degradation mechanisms, examination techniques, and methodology.

Initial Industry Response (4/26/01):

LL 3a: Update to Reflect Current Knowledge

Section 6.3.3, recommendations, states further: "The IP2 TS on SG tube integrity does not reflect current knowledge regarding SG degradation and failure mechanisms (e.g., hour glassing), and provides insufficient guidance regarding the type of information and level of detail to be reported to the NRC. For example, the licensee report containing the result of its SG examination does not provide any details regarding the data quality."

Industry Response: Develop appropriate technical specifications.

NEI 97-06 is a top-level document that describes the basic structure of an acceptable SG Program. It references a number of EPRI Guidelines that provide the detailed requirements. The structure of the industry's SG program is introspective; the requirements are regularly evaluated against new knowledge and techniques and revised as necessary to accommodate improvements. This flexibility is one of the strengths of the industry's program.

The Technical Specifications developed as part of the industry's SG Generic License Change Package reference the SG Program for their surveillance requirements. This approach does not make specific test or assessment methods part of a utility's license, and in this way allows the surveillance requirements to change in response to the evolving guidance in the SG Program. It is not advisable to prescribe specific methods at the Tech Spec level or this flexibility will be lost as license amendments will be needed to update the requirements. By their nature, the Technical Specifications proposed by industry will reflect the current knowledge of steam generator degradation mechanisms, examination techniques, and methodologies.

The underlying Guidance documents that provide the Steam Generator Program details are constantly being strengthened as part of their biannual revision process. The revisions reflect current knowledge of the SG degradation mechanisms, examination techniques, and methodologies. The nature of the industry initiative on NEI 97-06 requires that each PWR adopt the changes included in approved SGMP Guidelines and in interim guidance unless a plant develops a justification for deviation from the requirement.

Immediate Industry Actions:

Obtain NRC approval of the Steam Generator Program Generic License Change Package technical specification changes by June 2001.

Future Actions to be Tracked by SGMP: None

Resolution Status:

Industry Response (NRC Summary):

The industry has submitted the NEI SG Generic Change Package which includes proposed new technical specifics to replace existing technical specifications. The proposed technical specifications are performance based. Details of an SG program intended to ensure these performance criteria will be in the SG program located outside of technical specifications. The SG program will be developed consistent with guidelines in NEI 97-06 and sub-tier EPRI guideline documents. The guidelines are regularly evaluated against new knowledge and techniques and are revised as necessary. These revisions reflect current knowledge of SG degradation mechanisms, examination techniques, and methodologies.

No future action to be tracked by SGMP.

Staff Evaluation:

Existing technical specifications contain prescriptive requirements concerning inspection frequency, inspection sample sizes, repair limits, and repair methods. These requirements are out of date with respect to existing inspection technology and degradation mechanisms and are incomplete. These requirements do not, in-of-themselves, ensure that tube integrity is maintained.

The industry’s proposed generic change package would replace the prescriptive requirements in current technical specifications with performance-based requirements. The revised technical specifications would require implementation of an SG program which ensures that performance criteria commensurate with tube integrity consistent with the plant licensing basis are maintained. The technical specifications would require that the condition of the tubing be periodically assessed relative to these performance criteria. This performance based approach is focused on the bottom line; namely ensuring tube integrity is maintained and thus is adaptable to changes in degradation mechanisms and technology. Details of the SG program would be defined outside of technical specifications in accordance with industry guidelines. Industry would be responsible for ensuring that the guidelines are kept up to date.

The NEI SG generic change package is currently being reviewed by the staff. As part of this review, the staff must make a finding that the change package provides reasonable assurance that tube integrity will be maintained. The staff's final safety evaluation approving the generic change package will constitute closure of this issue.

Additional Industry Comments (8/9/02):

No further response is required. This item will be closed when the SG Program generic license change package is approved.

Issue LL 3b from Lessons Learned Report:

The industry should assess the adequacy of the technical specification regarding operational leakage limits.

Initial Industry Response (4/26/01):

LL 3b: Adequacy of Operational Leakage Limits

Section 6.3.3.4,of the Lessons Learned Task Force Report states further: "IP2 TS limit on primary-to-secondary leakage did not provide pro-active indication of upcoming tube failure. The experience from the IP2 event where the SG leakage did not exceed the TS limit before a tube failed indicates that IP2 TS leakage limits, by themselves, are not always sufficient to prevent such a failure or provide meaningful indication of an impending failure."

Industry Position: Existing industry guidance is adequate.

The current standard technical specification limit for primary-to-secondary leakage is 500 gpd per steam generator. The industry agrees that the 500 gpd limit is inadequate based on current knowledge. Consequently, the industry has developed detailed guidance that provides an ultimate primary-to-secondary leakage limit of 150 gpd, less than one third of the current standard limit. Lower leakage levels below 150 gpd could result in shutting down the plant; however, operation will never continue above 150 gpd except while the plant is shutting down.

The limit of 150 gallons per day per steam generator is based on operating experience gained from SG tube degradation mechanisms that result in tube leakage. The operational leakage limit is not a surrogate for structural integrity. SGTR is possible for some forms of degradation with no prior indication of leakage. The 150 gpd leakage rate along with the other performance criteria in the Steam Generator Program provide reasonable assurance that a single flaw leaking this amount will not propagate to an SGTR under the stress conditions of a LOCA or a main steam line rupture prior to detection by leakage monitoring methods and commencement of plant shutdown. The leakage limit of 150 gpd becomes more conservative for combined leakage from separate, smaller flaws. These flaws, because of their size, do not compromise structural integrity.

As indicated in (Draft) NUREG 1477, no limit, regardless how small, will guarantee that a tube rupture will not occur. However, the reduction in the leakage limit will increase the probability that a tube rupture can be averted.

The proposed reduction in the primary-to-secondary leakage limit was submitted to the NRC in NEI letter dated December 11, 2000 as part of the steam generator program generic license change package. The industry's voluntary initiative to implement NEI 97-06, Steam Generator Program Guidelines, incorporates the revised primary-to-secondary leakage guidance by reference.

No additional action by the industry is required. NRC Staff approval of the generic license change package is necessary to revise the technical specifications.

Immediate Industry Actions: None

Future Actions to be tracked by SGMP: None

Resolution Status:

Ind**ustry Response (NRC Summary):**

The industry is proposing to revise the current 500 gpd technical specification limit (measured at temperature) to 150 gpd (measured at room temperature) as part of the NEI SG Generic Change Package. Adjusting for water density at temperature, the revised limit is equivalent to 195 gpd at temperature. The EPRI guidelines provide for plant shutdown when leakage exceeds 75 gpd. The reduced leakage limit provides added assurance that should leakage occur, the plant will be shutdown before leakage occurs. As indicated by the NRC staff in NUREG 1477 (draft), no limit, no matter how small, will ensure that a tube rupture will not occur.

No future action to be tracked by SGMP.

Staff Evaluation:

Operating experience indicates that degraded SG tubes usually, but not always, exhibit leak before break behavior. There have been 188 unplanned or forced plant shutdowns in the U.S. since 1975 due to SG tube leakage. These unplanned shutdowns typically involve maximum leak rates ranging from 50 to 1000 gpd (0.035 to 0.7 gpm). Only eight of these shutdowns involved a tube rupture or failure event with leak rates exceeding 100 gpm. Effective leakage monitoring in conjunction with implementation of appropriate leakage limits has proven to be an effective approach for minimizing the incidence of tube failure and for providing added assurance of tube integrity. The industry proposal to reduce the technical specification LCO leakage limits and administrative leakage limits will further the effectiveness of these limits in preventing tube ruptures. However, these programs can never provide complete assurance against tube rupture even if the leakage limits are reduced to zero. This is evidenced by the fact that three of eight tube failures in the U.S. occurred without precursor leakage until moments before the event. Precursor leakage at IP-2 prior to the event was extremely low level and trending up very slowly, reaching a maximum value of only 3.4 gpd (per N-16) immediately prior to the event.

The staff is reviewing the industry proposal as part of its review of the NEI SG generic change package. No further action on this operational leakage limit issue is requested by the staff. The staff's final safety evaluation concerning the generic change package will constitute closure of this issue.

Additional Industry Comments (8/9/02):

No further response is required. This item will be closed when the SG Program generic license change package is approved.

Issue LL 4a from Lessons Learned Report:

The licensees should ensure that contractors supporting the SG examination perform in an acceptable manner. The industry initiative should provide reasonable assurance of contractor oversight by licensees.

Initial Industry Response (4/26/01):

LL 4a: Contractor Oversight

Industry Position: Enhanced guidance will be developed

The next revision of NEI 97-06 will address the issue. In the meantime, the SGMP Lesson Learned letter "SGMP Information Letter Concerning Lessons Learned from a Review of Recent Steam Generator Related Issues, dated September 29, 2000 provides guidance for the utility oversight of vendor activities (tube integrity assessment and in service inspection).

The issue of contractor oversight stems from the inspection experience at IP2 however, it is not specific to NDE. It is somewhat generic to the entire scope of steam generator management. The subject of the contractor oversight will be addressed in a generic manner in the next revision of NEI 97-06. Where applicable, industry guidelines will be revised to reflect changes to NEI 97-06.

Immediate industry actions: None

Future actions to be tracked by SGMP: A revision to NEI 97-06 reflecting this guidance will be available by January 2002.

Resolution status:

Industry Response (NRC Summary):

The next revision of NEI 97-06 will address this issue. In the meantime, the SGMP lessons learned letter dated September 29, 2000 provides guidance for utility oversight of vendor activities relating to tube integrity assessment and inspection. This guidance can be summarized as follows:

- Plants should have accessible personnel, knowledgeable in NDE and structural mechanics, who can integrate the inspection results associated with unusual conditions and assess their implications for tube integrity. A Level III inspection analyst should work closely with these personnel.

- Strong utility oversight must be instituted in areas of tube integrity assessment and inservice inspection if vendors are used to implement these areas of the utility's SG program. The utility should be actively involved in establishing the program, implementing its requirements, and carrying out its procedures where appropriate.

- Utility management has the prime responsibility for providing sufficient resources and support to personnel implementing the SG program.

No immediate industry actions necessary.

Future actions to be tracked by the SGMP: A revision to NEI 97-06 reflecting this guidance will be available by January 2002.

Staff Evaluation:

The SGMP lessons learned letter addresses this issue. Inclusion of this guidance in the next revision of NEI 97-06 will increase the visibility of this guidance and, thus, enhance its effectiveness. Although the guidance is very general, the staff believes it is on target. More detailed guidance would not be expected to add significantly to assurance of adequate contractor oversight. The key to ensuring adequate contractor oversight is management involvement and commitment to this effect by licensees.

The staff concludes that the industry appears headed on a path to resolve this issue. The staff hopes to be able to consider this issue closed once NEI 97-06 is revised appropriately. In the meantime, the staff considers this to be an open, low priority issue with no immediate safety concerns. This issues is not expected to impact the staff's review of the NEI generic change package.

Additional Industry Comments (8/9/02):

Contractor oversight responsibilities are being added to new revisions of the EPRI SG Guidelines and NEI 97-06 as they are revised. Revision 6 of the SG Examination Guidelines was approved on August 6, 2002. The In Situ Test Guidelines and Integrity Assessment Guidelines are currently being prepared. NEI 97-06 revision 2 will be issued after the generic license change package is approved.

Issue LL 4b from Lessons Learned Report:

In the near term, industry should ensure that lessons learned from the IP-2 experience are being used to ensure that effective SG tube integrity programs are being implemented by licensee implementation of IP-2 lessons learned.

Issue LL 4c from Lessons Learned Report:

In the longer term, industry should also use lessons learned from the IP-2 experience to strengthen the NEI 97-06 initiative. NEI should provide feedback to the NRC on the specific changes to planned to the 97-06 initiative based on the IP-2 experience, including a schedule for implementation of the changes.

Initial Industry Response (4/26/01):

LL 4b: Feedback – Application by Licensees of IP2 Lessons Learned

Section 6.5.3 of the Lessons Learrjed Task Force Report, recommendations, explains further: "Although the Task Group did not conduct an extensive review of the industry guidelines or the NEI initiative, the Task Group judged that weaknesses in the licensee's implementation of the industry guidelines, combined with shortcomings in the technical guidance itself, contributed to the situation encountered at IP2.

Industry Response: Enhance industry guidance.

The items identified in the NRC's SG Action Plan are technical. Their impact on the industry's SG Program requirements will be seen as changes to the EPRI SGMP Guidelines. For example, one of these Guidelines, the SG Examination Guidelines, is currently in the process of being revised. Its changes will address a number of IP2 lessons learned items including data quality, noise, site specific qualification, and use of computer tools to aid NDE data analysis.

The nature of the industry initiative on NEI 97-06 requires that each PWR adopt the changes included in approved SGMP Guidelines unless a plant develops a justification for deviation from the requirement. Therefore, once a Guideline is revised, the changes it adopts will have wide spread implementation by PWR licensees.

The industry has agreed to provide copies of the EPRI Guidelines to the NRC, so the NRC will be aware of changes as they are implemented. NEI forwarded copies of the current revisions to the NRC on April 9, 2001. NEI will incorporate a requirement to submit copies of future EPRI Guideline revisions to the NRC into Revision 2 of NEI 97-06.

The industry is involved in a series of meetings with the NRC that will address the resolution of steam generator technical issues, including the items identified in the staff's Steam Generator Action Plan. A protocol is being developed that will govern the resolution process. The protocol includes a data base that will track the actions identified for each issue. Final industry positions and NRC responses will be documented in written correspondence.

The industry recently participated in two NRC sponsored events, the Steam Generator Workshop and the Regulatory Information Conference, and presented information related to its steam generator activities.

In the fall of 2000, the SGMP reviewed information from the steam generator tube failure at IP2, the pressurization rate phenomenon identified in the ANO-2 pressure testing, and an annual summary of industry steam generator review visits. As a result of this review two letters were prepared, one letter addressed lessons learned and one provided interim guidance on in situ pressure testing. These letters were distributed to the industry in September and October 2000. NEI forwarded copies of the letters to the NRC on November 8 and November 30, 2000.

For the last five years, the industry has conducted a steam generator review program that assesses the adequacy of individual plant SG Programs with respect to NEI 97-06 guidance and provides feedback to the plant on areas of improvement. This process has been invaluable in providing a means for plants to assess the adequacy of their programs. The results of the SG review visits are summarized annually and are available for utility review.

In summary, the following feedback mechanisms are in development or in place:

1. The industry and NRC are conducting a series of meetings that will address steam generator technical issues. A protocol is being developed that will formalize the closeout process for all the issues addressed.

2. NEI recently provided copies of all the EPRI SG Guidelines to the NRC. A requirement to submit copies of future EPRI Guideline revisions to the NRC will be incorporated into Revision 2 of NEI 97-06.

3. Plants are required to justify any deviation of their SG program requirements from the intent of the EPRI Guidelines or NEI 97-06. This justification must be documented, approved, and retained as part of the plant's SG Program records. The evaluations are available for NRC review as part of its inspection activities at a site.

4. Assessments of plant SG Program conformance to the requirements in NEI 97-06 and the referenced EPRI Guidelines are conducted by the industry and reviewed with the site. This information is available to all PWRs.

5. The industry will continue to participate in NRC sponsored events on steam generator issues as requested.

Immediate Industry Actions:

Issue the SG Action Plan protocol.

Future Actions to be Tracked by SGMP:

Issue revision 2 to NEI 97-06 by January 2002.

Resolution Status:

LL 4c: Feedback – Planned Changes to NEI 97-06 Initiative

Section 6.5.3 of the Lessons Learned Task Force Report explains further: "Industry has not yet taken steps to incorporate lessons learned from the event into existing Guidance documents. Industry representatives (i.e. NEI) have stated that such an effort is being undertaken, but the results are not yet available."

Industry Response: Enhance industry guidance.

Industry has agreed to provide written responses to the NRC for each of the industry items identified in the NRC SG Action Plan. These responses will identify the Guidelines that are impacted by the item. A protocol is being developed for this process that will document the completion of each industry action item.

The industry has agreed to provide copies of the EPRI Guidelines to the NRC so the NRC will be aware of the changes as they are implemented. Copies of the current revisions were forwarded to the NRC on April 9, 2001. A requirement to submit copies of future EPRI Guideline revisions to the NRC will be incorporated into Revision 2 of NEI 97-06.

The changes resulting from the NRC's SG Action Plan items are only a small part of the information that is being assessed for incorporation into the EPRI Guidelines. The industry's SG Program guidance is designed to change in response to information obtained from experience or new technology. The EPRI SGMP routinely reviews industry events for their impact on SG Program guidance. The paragraphs below summarize the various activities completed or currently underway to incorporate recent experience.

1. The SGMP commissioned a pressurization rate study to evaluate the results of the ANO Unit 2 laboratory pressure testing. As a result of this study, interim guidance on in situ pressure testing of SG tubes was distributed to the industry in October 2000. The study will be submitted to the NRC upon completion.

2. The SGMP reviewed information from the steam generator tube failure at IP2, the pressurization rate phenomenon identified in the ANO-2 pressure testing, and an annual summary of industry steam generator review visits and prepared a lessons learned letter which was distributed to the industry in September 2000.

3. The lessons learned and interim in situ testing guidance letters were followed by a number of presentations on the underlying events and other industry experiences at recent Technical Advisory Group (TAG) meetings. The TAG meetings provide a regular forum for exchange of information between SG engineers.

4. The industry uses information in letters such as those discussed above in its SG Program Review Visits.

5. As stated above, the information distilled from the IP2 event and other industry experience will be factored into the revision process for the appropriate EPRI SGMP Guidelines. One of these Guidelines, the SG Examination Guidelines, is already in the process of being revised. Its changes will address data quality, noise, site specific qualification, and use of computer tools to aid NDE data analysis. Each guideline revision is accompanied by a summary of the important changes and direction for implementation by licensees.

The nature of the industry initiative on NEI 97-06 requires that each PWR adopt the changes included in approved SGMP Guidelines unless a plant develops a justification for deviation from the requirement. Therefore, once a Guideline is revised, PWR licensees will normally implement the changes it captures.

In addition to the guidelines, NEI coordinates a SG Review Board process that interprets the various requirements when questions arise. NEI posts the interpretations on the NEI Website for use by industry personnel. NEI forwarded a list of the active interpretations to the NRC on November 9, 2000. A requirement to periodically submit future Review Board decisions to the NRC will be incorporated into revision 2 of NEI 97-06.

Immediate Industry Actions:

Issue the SG Action Plan protocol.

Future Actions to be Tracked by SGMP:

Issue revision 2 to NEI 97-06 by January 2002.

Resolution Status:

Industry Response (NRC Summary):

Industry has provided written responses to the NRC for each of the industry items identified in the NRC action plan, including the IP-2 lessons learned. These responses identify the guidelines that are impacted by each issue. A protocol is being developed for this process that will document the completion of each industry action item.

These issues relate to NEI 97-06 and the sub-tier EPRI guideline documents and to the implementation of these guidelines. As discussed in the industry responses to the action plan issues, the issues are adequately addressed in the most recent guideline revisions or the guidelines will be enhanced to address these issues in future revisions.

The industry initiative on NEI 97-06 requires that each licensee adopt the latest revision of the guidelines unless the licensee develops and documents a basis for deviating from the requirement. Therefore, once the guideline is revised, the revisions will have widespread implementation across the industry.

Revision 2 of NEI 97-06 will provide that NRC will be provided with copies of future revised EPRI guidelines.

The industry has also reviewed available information regarding recent experience from IP-2 and ANO-2. As a result, SGMP issued two letters to the industry which were also provided to the NRC. These included a September 29, 2000 letter concerning lessons learned from recent SG related issues and an October 13, 2000 letter with interim guidelines on in situ pressure testing.

For the past five years, the industry has conducted a steam generator review program that assesses the the adequacy of individual plant SG programs with respect to NEI 97-06 guidance and provides feedback to the plant on needed areas of improvement. This process has been invaluable in providing a means for plants to assess the adequacy of their programs. The results of the SG review visits are summarized annually and are available for utility review.

Immediate Industry Action: Issue the SG Action Plan Protocol.

Future Action to be Tracked by SGMP: Issue revision 2 of NEI 97-06 by January 2002.

Staff Evaluation:

Industry responses to the individual NRC action plan issues, including IP-2 lessons learned, have been reviewed and commented on by the NRC staff. The staff will have the opportunity to observe the licensees' implementation of these guidelines and documented deviations from these guidelines as part of the regional baseline inspection program.

The staff is reviewing the NEI SG generic change package. As part of this review, the staff must make a finding that the change package provides reasonable assurance that tube integrity will be maintained. The staff's final safety evaluation approving the generic change package will constitute closure of these issues (i.e., LL 4b and 4c).

Additional Industry Comments (8/9/02):

No further response is required. This item will be closed when the SG Program generic license change package is approved.

Issue LL 4b from Lessons Learned Report:

Over the longer term, industry should also use the lessons learned from the IP-2 experience to strengthen the NEI 97-06 initiative. NEI should provide feedback to the NRC on the specific changes planned to the NEI 97-06 initiative based on the IP-2 schedule.

Initial Industry Response (4/26/01):

LL 4b: Feedback – Application by Licensees of IP2 Lessons Learned

Section 6.5.3 of the Lessons Learrjed Task Force Report, recommendations, explains further: "Although the Task Group did not conduct an extensive review of the industry guidelines or the NEI initiative, the Task Group judged that weaknesses in the licensee's implementation of the industry guidelines, combined with shortcomings in the technical guidance itself, contributed to the situation encountered at IP2.

Industry Response: Enhance industry guidance.

The items identified in the NRC's SG Action Plan are technical. Their impact on the industry's SG Program requirements will be seen as changes to the EPRI SGMP Guidelines. For example, one of these Guidelines, the SG Examination Guidelines, is currently in the process of being revised. Its changes will address a number of IP2 lessons learned items including data quality, noise, site specific qualification, and use of computer tools to aid NDE data analysis.

The nature of the industry initiative on NEI 97-06 requires that each PWR adopt the changes included in approved SGMP Guidelines unless a plant develops a justification for deviation from the requirement. Therefore, once a Guideline is revised, the changes it adopts will have wide spread implementation by PWR licensees.

The industry has agreed to provide copies of the EPRI Guidelines to the NRC, so the NRC will be aware of changes as they are implemented. NEI forwarded copies of the current revisions to the NRC on April 9, 2001. NEI will incorporate a requirement to submit copies of future EPRI Guideline revisions to the NRC into Revision 2 of NEI 97-06.

The industry is involved in a series of meetings with the NRC that will address the resolution of steam generator technical issues, including the items identified in the staff's Steam Generator Action Plan. A protocol is being developed that will govern the resolution process. The protocol includes a data base that will track the actions identified for each issue. Final industry positions and NRC responses will be documented in written correspondence.

The industry recently participated in two NRC sponsored events, the Steam Generator Workshop and the Regulatory Information Conference, and presented information related to its steam generator activities.

In the fall of 2000, the SGMP reviewed information from the steam generator tube failure at IP2, the pressurization rate phenomenon identified in the ANO-2 pressure testing, and an annual summary of industry steam generator review visits. As a result of this review two letters were prepared, one letter addressed lessons learned and one provided interim guidance on in situ pressure testing. These letters were distributed to the industry in September and October 2000. NEI forwarded copies of the letters to the NRC on November 8 and November 30, 2000.

For the last five years, the industry has conducted a steam generator review program that assesses the adequacy of individual plant SG Programs with respect to NEI 97-06 guidance and provides feedback to the plant on areas of improvement. This process has been invaluable in providing a means for plants to assess the adequacy of their programs. The results of the SG review visits are summarized annually and are available for utility review.

In summary, the following feedback mechanisms are in development or in place:

6. The industry and NRC are conducting a series of meetings that will address steam generator technical issues. A protocol is being developed that will formalize the closeout process for all the issues addressed.

7. NEI recently provided copies of all the EPRI SG Guidelines to the NRC. A requirement to submit copies of future EPRI Guideline revisions to the NRC will be incorporated into Revision 2 of NEI 97-06.

8. Plants are required to justify any deviation of their SG program requirements from the intent of the EPRI Guidelines or NEI 97-06. This justification must be documented, approved, and retained as part of the plant's SG Program records. The evaluations are available for NRC review as part of its inspection activities at a site.

9. Assessments of plant SG Program conformance to the requirements in NEI 97-06 and the referenced EPRI Guidelines are conducted by the industry and reviewed with the site. This information is available to all PWRs.

10. The industry will continue to participate in NRC sponsored events on steam generator issues as requested.

Immediate Industry Actions:

Issue the SG Action Plan protocol.

Future Actions to be Tracked by SGMP:

Issue revision 2 to NEI 97-06 by January 2002.

Resolution Status:

Industry Response (NRC Summary):

Enhance industry guidance

Industry has provided written responses to the NRC for each of the industry items identified in the NRC action plan, including the IP-2 lessons learned. These responses identify the guidelines that are impacted by each issue. A protocol is being developed for this process that will document the completion of each industry action item.

Copies of the current revisions to each of the EPRI guidelines was provided to the NRC on April 9, 2001. Revision 2 of NEI 97-06 will provide that NRC will be provided with copies of future revised EPRI guidelines.

The EPRI guidelines are periodically revised in response to information obtained from experience or new technology. The EPRI SGMP routinely reviews industry events such as IP-2 for their impact on SG Program guidance. One of these guidelines, the SG examination guidelines, is already in the process of being revised. Its changes will address data quality, noise, site specific qualification, and the use of computer tools to aid NDE data analysis.

For the past five years, the industry has conducted a steam generator review program that assesses the the adequacy of individual plant SG programs with respect to NEI 97-06 guidance and provides feedback to the plant on needed areas of improvement. This process has been invaluable in providing a means for plants to assess the adequacy of their programs. The results of the SG review visits are summarized annually and are available for utility review.

The SGMP reviewed information from the SG tube failure at IP-2, the pressurization rate effect observed during tube pressure testing for ANO-1, and the annual summary of industry steam generator review visits. A lessons learned letter was issued to the industry in September 2000. In addition, interim guidance on in situ pressure testing was issued to the industry in October 2000.

Immediate Industry Actions: Issue the SG Action Plan protocol.

Futures Actions to be Tracked by SGMP: Issue revision 2 to NEI 97-06 by January 2002.

Staff Evaluation:

Industry responses to the individual NRC action plan issues, including IP-2 lessons learned, have been reviewed and commented on by the NRC staff. The staff will have the opportunity to observe the licensees' implementation of these guidelines and documented deviations from these guidelines as part of the regional baseline inspection program.

The staff is reviewing the NEI SG generic change package. As part of this review, the staff must make a finding that the change package provides reasonable assurance that tube integrity will be maintained. The staff's final safety evaluation approving the generic change package will constitute closure of these issues (i.e., LL 4b and 4c).

Additional Industry Comments (8/9/02):

No further response is required. This item will be closed when the SG Program generic license change package is approved.