August 2, 2001

James Riley
Nuclear Energy Institute
1776 I street, NW Suite 400
Washington, DC 20006-3708

SUBJECT: NEI Steam Generator Generic Change Package

Dear Mr. Riley:

Enclosed for your review is a draft paper with four attachments regarding issues pertaining to the subject change package. This draft is intended to serve as a basis for discussion at our upcoming meeting on August 29, 2001.

Sincerely,

/ra/

Emmett Murphy
Materials and Chemical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

August 2, 2001

James Riley
Nuclear Energy Institute
1776 I street, NW Suite 400
Washington, DC 20006-3708

SUBJECT: NEI Steam Generator Generic Change Package

Dear Mr. Riley:

Enclosed for your review is a draft paper with four attachments regarding issues pertaining to the subject change package. This draft is intended to serve as a basis for discussion at our upcoming meeting on August 29, 2001.

Sincerely,

Emmett Murphy
Materials and Chemical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

Distribution: EMCB RF   JStrosnider   SG Service List

DOCUMENT NAME: G:\EMCB\Murphy\Comments Re NEI SGGGCP.wpd
INDICATE IN BOX: "C"=COPY W/O ATTACHMENT/ENCLOSURE, "E"=COPY W/ATT/ENCL, "N"=NO COPY

OFFICE	EMCB:DE	
NAME	ELMurphy:elm	
DATE	8/ 2 /01	

OFFICIAL RECORD COPY

Draft

Issues pertaining to NEI SG Generic Change Package

The NEI Steam Generator Generic Change Package proposes a revised regulatory framework for ensuring tube integrity is maintained. The change package includes a proposed administrative technical specifications which requires that an SG program be developed and implemented to ensure that (NRC approved) tube integrity performance criteria are maintained. The administrative technical specifications will also require that periodic condition monitoring be performed to verify that the performance criteria are met.

Details of the SG program, including condition monitoring details, would be located outside of the technical specifications in licensee controlled documents. Licensees would commit to develop the details of the SG program consistent with NEI 97-06. NEI 97-06 defines the key elements of the SG program to ensure the performance criteria are met. NEI 97-06 provides general guidelines concerning how these programmatic elements should be implemented. Detailed industry guidelines concerning the implementation of these elements is provided in EPRI guideline documents referenced in NEI 97-06.

The staff is reviewing NEI 97-06 for possible endorsement as an acceptable approach for ensuring SG tube integrity is maintained. The staff has some relatively minor comments pertaining Revision 1D of these guidelines which are provided in Attachment A. The staff understands that Revision 2 of the NEI 97-06 is forthcoming.

It had not been the staff's intention to review or endorse the sub-tier EPRI guideline documents. It was the staff's expectation that detailed EPRI guidelines for implementing the SG program would be sufficiently well developed such as to result in improved tube integrity performance compared to past performance under the existing regulatory framework. These detailed guidelines were not expected to resolve all issues that have always existed and which will continue to exist under the new regulatory framework. There was also the expectation that the EPRI guidelines would continue to evolve over time in response to technology changes, lessons learned from operating experience, and industry and NRC studies (e.g., NRC SG mockup and ECT round robin, NRC DPO action plan). It has been the staff's intention to make it clear in the RIS to accompany issuance of the staff's SE on the NEI SG generic change package that the guidelines are evolutionary documents which do not necessarily have all the answers to situations licensees may encounter. The RIS would underscore licensee responsibilities to look beyond the industry guidelines as necessary to ensure that the tube integrity performance criteria are maintained.

However, industry representatives have recently indicated plans for revising the guidelines to permit inspection intervals (and condition monitoring intervals) significantly beyond current industry guidelines and current regulatory requirements. The staff understands that future guidelines may allow for inspection intervals ranging from 5 to as much as 22 EFPY for SGs with alloy 600 TT and 690 TT tubing. The staff is concerned that certain sub-tier EPRI guidelines are not sufficiently well developed to support extended operating intervals beyond current requirements with reasonable assurance that the tube integrity criteria will be maintained with no significant increase in risk.

The staff has reviewed certain provisions of the EPRI guideline documents which are critical to the effectiveness of condition monitoring to promptly detect tubing conditions not meeting the performance criteria. It is the staff's position that the applicable regulatory standard for what constitutes an acceptable condition monitoring assessment is Criterion 16 of 10 CFR 50, Appendix B; namely, measures shall be established to ensure that conditions adverse to quality are promptly detected and corrected. The staff's review has identified a number of issues in the EPRI guidelines which relate to the ability of condition monitoring to fulfill its Appendix B obligation. These issues are identified in Attachment B of this paper. Staff concerns relative to these issues potentially would be significantly aggravated, depending on the specific methodology employed to justify the longer inspection intervals. Thus, the issues in Attachment B appear to be the highest priority issues from the standpoint of having an adequate justification to support extended inspection intervals beyond current regulatory restrictions.

The staff has reviewed many of the industry responses to “NRC Action Plan Issues” stemming from NRC RIS 2000-22 and the NRC Indian Point 2 Lessons Learned Report. These action plan issues relate primarily to EPRI guideline documents. The staff's review of the industry response to the action plan issues is provided in Attachment C. As discussed in Attachment C, the staff considers that a number of action plan issues remain unresolved at the present time. For steam generators with active degradation mechanisms, certain issues in Attachment C as well as Attachment B may also need resolution before having adequate justification to support extended inspection intervals beyond current regulatory restrictions.

The staff is evaluating whether it can proceed with review and approval of the generic change package pending resolution of these issues. The staff has concluded preliminarily that it can proceed with review and approval provided current inspection interval restrictions are essentially maintained. Attachment D summarizes the necessary restrictions. This preliminary finding is based on the rationale that the proposed generic change package would be expected to reduce assurance of tube integrity only in cases where longer inspection intervals than currently permitted are implemented without adequate justification.

With respect to operating interval restrictions, one option would be to define the restrictions in the technical specifications in a manner similar to that for tube repair criteria or repair methods (see Attachment D). That is, the approved restrictions would appear in a document outside technical specifications. The technical specifications would require that changes to these restrictions would be subject to NRC review and approval.

Attachment A

Comments Relating to NEI 97-06, Revision 1D

1. Page 8, 1st paragraph, 1st Sentence

   The words “primary pressure stress” conflict with the words “membrane stress” in the SG Tube Integrity Technical Specification Bases and with the words, “primary membrane stress. The staff believes that “stress” (primary or secondary) is the proper wording, but if the industry disagrees, the staff would like to understand the basis. Irrespective, the wording should be consistent among all the documents.

2. Section 2.3

   The description of the basis for the operational leakage performance criterion should also state that the performance criterion matches the LCO operational leakage limit in the technical specifications. This limit provides added assurance that should tube leakage develop, the plant will be shutdown before rupture of the tube.

3. Section 3.1.3, 3rd sentence

   NDE flaw sizing and leakage prediction models should also be identified as potential significant sources of uncertainty.

4. Page 12, 5th paragraph

   This paragraph is confusing as to whether voltage based limits are an ARC and whether NRC approval is needed prior to a plants initial use of voltage based limits. This can be fixed by replacing the words “a voltage-based repair limit per GL 95-05 or other alternate repair criteria (ARC)” with the words “or alternate repair criteria (ARC) such as a voltage-based repair limit in accordance with Generic Letter 95-05.

5. Page 12, 6th paragraph

   This paragraph should be revised consistent with the words agreed to in the latest version of the SG Tube Integrity Technical Specification Bases.

6. Page 12, last paragraph.

   This one sentence paragraph has no context. Suggest deleting.

7. Section 3.1.4, last paragraph

   The first sentence should be revised to state that NRC approval is required prior to a plant’s initial use of any specific repair method other than plugging.

8. Section 3.1.7

   The staff understands that this section will be revised as discussed by NEI at April 26, 2001 meeting with NRC staff.

9. Appendix B, Definition of "Limiting Design Basis Accident"

   The definition is incorrect with respect to what is the limiting accident from a structural standpoint. There may be loadings other than pressure which affect structural integrity. The limiting accident is that which results in the minimum margin with respect to meeting the structural performance criteria.

10. Appendix B, Definition of "Primary Stress"

    This definition is incorrect. This definition should be corrected consistent with Section III of the ASME Code, or should be deleted.

11. Appendix B, Definition of "Repair Limit"

    The definition should include a statement that repair limits must be reviewed and approved by the NRC staff.

12. Appendix B, Definition of "Secondary Stress"

    The definition is incorrect. The example is also incorrect since stresses associated with dynamic, hydrodynamic, and flow induced forces are generally primary stress, not secondary stress. This definition should be corrected consistent with Section III of the ASME Code, or should be deleted.

Attachment B

Technical Issues/EPRI Guideline Documents

Introduction:

This attachment provides staff comments on eight topics in the EPRI guidelines which relate to the ability of condition monitoring to fulfill its Appendix B obligation. Some of these comments are redundant to NRC SG Action Plan Issues stemming from RIS 2000-22 and the Indian Point 2 Lessons Learned Report.

Topic 1: Performance Standards

Performance **standards** define the circumstances when the SG tubing can be said to meet the SG tube integrity performance criteria.

NEI 97-06 defines a general “performance standard” for evaluating when the performance criteria are met. Namely, the tube integrity assessment relative to the performance criteria must be conservative, accounting for all significant sources of uncertainty.

The EPRI tube integrity assessment guidelines, Section 5.2, provides two performance standards for tube integrity assessments relative to the deterministic structural performance criteria (e.g., 3 delta p). The first of these standards applies to each defect or indication under consideration. Each flaw or indication must satisfy the performance criteria with a probability of 0.90 evaluated at 50% confidence. The second of these standards applies to the universe of flaws or indications in a steam generator. All flaws or indications must satisfy the deterministic performance criteria with a probability of 0.90 evaluated at 50% confidence.

The technical basis for the 0.9 probability standard is not discussed in the guidelines. It departs from conventional 0.95 standards typically applied in cases where one seeks to bound a situation with a high level of assurance.

The staff further notes that the EPRI performance standards are applied inconsistently in the tube integrity assessment guidelines and in the in situ pressure test guidelines. For example, Sections 8 and 9 of the tube integrity assessment guidelines define a simplified statistical strategy for performing tube integrity assessment. These strategies do not address meeting the EPRI performance standard applicable to the universe of flaws for satisfying the deterministic structural performance criteria. These strategies only address the performance standard to be applied to each individual flaws.

Similarly, screening criteria in the in situ test guidelines are based on consideration of the EPRI performance standard for individual flaws only. These guidelines do not address the EPRI performance standard to be applied to the universe of flaws.

The EPRI performance standard for individual flaws does not ensure with high confidence that all flaws in the steam generators will satisfy the applicable performance criteria. For example, consider five flaws which each satisfy the 3 delta p criterion with a probability of 0.9. The probability that all five indications satisfy 3 delta p is only 0.59. This means there is a relatively high probability (i.e., 0.41) that at least one of these five flaws actually doesn't meet 3 delta p.

A recent operational assessment for Indian Point 2 using a statistical Monte Carlo approach suggests that there may be a little as an order of magnitude difference between the conditional probability of burst at 3 delta p and the conditional probability of burst at MSLB. For the hypothetical five flaws described earlier, the Indian Point 2 trend would suggest a conditional probability of burst of 0.041 under MSLB conditions. This number is large enough to suggest there may be potential severe accident risk implications associated with the condition of the tubing which may not be acceptable for certain situations (e.g., freespan cracks).

In conclusion, an appropriate performance standard applicable to the population of flaws is needed when using statistical methods to account for various uncertainties. When using non-statistical methods, uncertainties should be conservatively bounded.

The EPRI tube integrity assessment guidelines, including Section 7, "Allowable Accident Induced Tube Leakage," do not address performance standards for assessing accident induced leakage relative to the applicable performance criteria. Appendix G of the guidelines states that Monte Carlo assessment can be used to generate a 90th percentile leakage estimate at 50% confidence (i.e., 90/50) for condition monitoring and a 95/95 estimate for operational assessment. The EPRI guidelines do not state that these are the performance standards that should be used for tube integrity assessment.

Topic 2: NDE Uncertainties

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).

Topic 3: Needed Attributes of Performance Demonstration to Quantify NDE System Uncertaint.

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. The staff believes a site applicable performance demonstration for a given flaw type and associated NDE technique should include the following attributes:

a. quantify flaw sizing performance of the total NDE system (technique, personnel, site data analysis and analysis resolution procedures) relative to ground truth. Where voltage is the pertinent flaw size parameter, sizing performance refers to the variability (repeatability) of the NDE system voltage measurement for a given flaw.

2. include a statistically significant number of flawed tube specimens over the full range of flaw sizes of interest.

3. utilize flawed tube specimens which are representative of conditions at the site in terms of flaw morphology, tube and support geometry, flaw signal response, noise, and signal to noise.

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.

Topic 4: In Situ Test Screening Criteria

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.

Topic 5: In Situ Pressure Test Sample Criteria

The EPRI in situ test guidelines state that in cases where more than five indications are found to exceed the screening criteria, that only a sample of the affected indications need be tested. The staff notes that such a sampling strategy lacks a rigorous technical basis and is not consistent with either of the performance standards in Section 5.2. For example, consider twenty five indications found to exceed the screening criteria. Consider also that only five of these are tested (presumably those that appear to be the most limiting) as permitted by the guidelines and all successfully pass the test. Because of the randomness of much of the eddy current sizing error and the variability of material properties from tube to tube, it is possible that the actual most limiting indications are not those tested. Any sampling plan should be justified by statistical analysis of significant sources of uncertainty.

Section 4.2 of the EPRI in situ test guidelines states that if NDE sizing uncertainty can not be adequately characterized or bounded, the utility should consider testing a minimum of five indications in an effort to develop an appropriate technical basis for future screening. The staff notes that under these circumstances, in situ testing should always be performed to demonstrate that the affected tubes are **currently** meeting the performance criteria. (An exception would be in cases where empirical burst and leakage models have been developed as a function of NDE sizing parameters where the data set is sufficiently robust to be fully reflected in the burst and leakage uncertainty models.) A sampling strategy for in situ testing is only justified if the ability of the NDE system to discriminate flaws potentially exceeding the performance criteria from among a population of flaws has been demonstrated. The EPRI guidelines provide no guidance on how such a capability may be demonstrated.

Topic 6: Burst and Leakage Models Based on Prior In Situ Test Results

Section 5.5.2 of the EPRI tube integrity assessment guidelines addresses the use of prior in situ test data in empirical burst pressure models as a function of an NDE measurement parameter. Such models may be particularly useful in cases where NDE sizing uncertainty has not been well characterized by an appropriate performance demonstration. In such cases, however, the guidelines should specify that the test data set for burst include a statistically significant number of data samples with burst pressures above **and** below the burst pressure performance criteria. This is necessary to ensure that there is a correlation between burst pressure and the NDE measurement parameter and that flaws with potentially unacceptable burst pressures can be discriminated from among the total population of flaws on the basis of the NDE measurement. Similarly, the guidelines for accident leakage should specify that the leakage data set should include a statistically significant set of leakers and non-leakers at the limiting accident pressure and the leakage data should cover the full range of interest.

Topic 7: Assessment of Incomplete In Situ Test Results

In-situ pressure tests may be terminated prior to reaching the target pressure in instances where tube leakage occurs and exceeds test system capacity. Section 7 (also Section 5.2.7) of the EPRI in situ test guidelines states that 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 may be verified by via visual or ECT examination or by extrapolation of the leakage data. The staff is concerned that the guidance provided to this effect may be non-conservative in some cases.

First, the staff does not agree that the absence of fish mouthing or significant crack tip extension necessarily implies that the burst pressure was not reached at the maximum test pressure, unless the maximum test pressure was held for some period of time. If the length of the crack exceeds the critical crack length for the maximum test pressure reached, it is possible that the point of incipient gross ligament tearing and, thus, burst was reached.

Once the crack has opened sufficiently to allow leakage to exceed the test system capacity, pressure drops, eliminating the driving force needed to push the crack into a fish mouth configuration with accompanying crack tip displacement. Thus, further evidence is needed (beyond demonstrating the absence of fish mouthing or crack tip extension) before it can be concluded that the burst pressure has not been reached.

Second, if the flaw was in fact at the point of incipient gross ligament tearing at the time the test was terminated, the leakage extrapolation method described in the guideline cannot be used to demonstrate that crack extension would not have occurred had the maximum test pressure been held. This methodology does provide information concerning the length of the throughwall component of the crack, but does not in-of-itself describe the overall size and shape of the flaw. One would have to consider other additional available information (e.g., pre- and post-test NDE) to assess the actual burst strength of the subject flaw.

Third, the guideline does not provide guidance on the need for rigorous treatment of uncertainties (e.g., uncertainties related to NDE measurements, material properties, and burst and leakage models) to ensure that the outcome of the assessment is consistent with the appropriate performance standards for demonstrating the tube integrity performance criteria are met.

Topic 8: Inspection and Condition Monitoring Intervals

The industry has informed the staff of its intention to revise Revision 5 of the EPRI PWR SG Examination Guidelines providing guidance for extending the length of SG inspection intervals significantly beyond what is currently permitted by the guidelines. The staff is concerned that without adequate justification, longer inspection intervals may result in condition monitoring being unable to fulfill its 10 CFR 50, Appendix B, Criterion 16 obligation; namely, **prompt** detection of conditions adverse to quality. Longer inspection intervals also may lead to increased risk under these circumstances. Longer intervals raise potential new issues. For example, predictive models for predicting when new degradation may initiate and subsequent flaw growth rates must be incorporated into tube integrity assessments. These models will add substantial uncertainty to the results of tube integrity assessments which will need to be accounted for. As another example, flaw growth rates are known to vary from cycle to cycle. There is already uncertainty related to the application of previously observed growth rates to projected growth rates during the next operating cycle. Projecting such growth rates over several cycles into the future will add further uncertainty to this process. Finally, and most importantly, the staff has not had the opportunity to review the details of how licensees would go about justifying longer inspection intervals. In addition, many of these details are not currently available to the staff.

The staff has the following comments pertaining to draft Revision 6 of the EPRI tube examination guidelines pertaining to the prescriptive criteria for inspection intervals applicable to SGs with Alloy 690 TT tubing:

1. The definition of “active damage mechanism” needs to tightened up such as to ensure active degradation is considered “active.” Under the existing definition, the u-bend cracking mechanism at Indian Point 2 would be considered non-active. Note, only one

tube at Indian Point exhibited an indicated growth rate greater than 10% (in terms of average depth) and the maximum growth rate was 11%. In terms of maximum depth growth rate, only 4 tubes exhibited a growth rate exceeding 10%, and none exceeded 24%.

An average growth rate above zero would seem to imply active degradation. The inspection interval should not exceed that supported by the operational assessment.

2. The guideline states that the SGs shall be examined with sequential periods of 144, 108, 72, and 60 EFPM. We gather that the 144 can only be applied to the period of operation immediately following the first inservice inspection. We assume it is not the intent of the guidelines to suggest that SGs which have already operated for twelve years could now be permitted to begin the above mentioned sequence starting with 144 EFPM. All this needs to be clarified.

3. The guideline states that 50% of the tubes in each SG should be inspected by the mid-point of the period. Does this permit the initial 50% sample to be taken after say only 18 EFPM with the remaining inspections to be performed at the end of the 144 EFPM period? The minimum period between SG inspections needs to be clarified.

4. What is the basis for the proposed inspection and condition monitoring intervals? What is the basis for ensuring that these intervals ensure the "prompt" detection (see criterion 16 of Appendix B, Part 50) of tube conditions exceeding the performance criteria?

5. How will degradation experience at similar units be considered? Under what circumstances might this experience dictate that a shorter inspection interval is appropriate? Would one revise the inspection schedule mid-way through the interval in response to such experience? What are the specific criteria to this effect?

6. What are the criteria defining the actions to be taken in the event of a water chemistry excursion to determine whether the inspection schedule should be revised?

The staff has similar comments pertaining to SGs with 600 TT tubing.

The staff has not evaluated the proposed revision 6 guidelines for performance based and risk informed inspections in detail. The staff does not have a copy of EPRI Report TR-114736-V1 and other referenced documents describing key details of the methodology and the technical bases. However, the staff has the following comments on what is actually contained in the draft revision 6.

1. Projecting the condition of the tubing at the time of the next refueling outage has proved to be a challenging exercise, with large uncertainties that need to be accounted for. Projecting the condition of the tubing over multiple cycles constitutes an even more challenging exercise with even greater uncertainty. Given the large uncertainties, is it appropriate to operate the SGs to the point where the most limiting tube is predicted to just meet the performance criteria?

2. What is the "condition monitoring limit" (CML) and how does it compare to the tube integrity performance criteria?

3. Figures 4-1 through 4-3 state that inspection intervals may extend to the nearest of the smallest of t_c or t_w (Figure 4-1) or of t_{ia} or t_{id} (Figures 4-2 and 4-3). This can be interpreted as meaning that the inspection interval can be between the two limits so long as it is closer to the lower limit. What is the technical justification for exceeding either limit?

4. Does "detected mechanisms" in Figures 4-2 and 4-3 refer to "active degradation" as defined in Appendix F? (See earlier comment regarding definition of active degradation.) If not, what is the definition?

5. Figure 4-4 contains a prediction of time to corrosion degradation based on service experience from first generation SGs adjusted for improvements to second generation SGs. Figure 4-4 suggests that it is acceptable to operate until 0.1% of the tubes are predicted to exceed the repair limit. How is this consistent with the overall goal or performance standard that there should be a high probability that all tubes meeting the performance criteria?

6. The Figure 4-4 curves are best estimate. What is the uncertainty model to be used in conjunction with this model to ensure the appropriate performance standards are met? The staff notes that there will be significant tube to tube and plant to plant variabilities in material properties, material micro structure, stress level (including residual stress), and chemistry environment which may affect the time to corrosion degradation.

7. The draft guidelines define a lead plant approach for determining time to corrosion as an alternative to Figure 4-4. Although the details are in a referenced document (not available to the staff), the approach basically permits extended inspection intervals for time periods until accumulated operating time exceeds that of the lead plant (if the lead plant has been corrosion free) or exceeds that where the lead plant would be required to plug tubes in order to meet the performance criteria. The types of uncertainties under this alternative approach are similar to those associated with the use of Figure 4-4. What are these uncertainties and how are they to be addressed?

8. Comment: A similar approach to f. and g. was applied by the industry for estimating the lifetime of Westinghouse mechanical plugs in response to NRC Bulletin 89-01. The approach accounted for operating temperature differences among plants and heat to heat micro structural differences. The predictive methodologies were not entirely successful in predicting the useful life of the plugs and needed repeated revisions through the years.

Attachment C

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

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.

Industry Response (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.

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

Issue LL 2l 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).

Industry Response (Summary):

The industry has developed new guidance relative to this issue. 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.

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 the staff concludes that issue LL 2I is closed.

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

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.

Industry Response:

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.

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

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.

Industry Response:

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.

4. 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?

5. Same questions for Alloy 600 TT.

6. Same questions for Alloy 690 TT.

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

8. 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.

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

Issue LL 2c of Lessons Learned Report:

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

Industry Response:

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.

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

Issue 4 from RIS 2000-22:

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

Industry Response:

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.

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

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.

Industry Response (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.

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

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.

Industry Response (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.

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

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.

Industry Response (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.

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

Issue LL 2i from Lessons Learned Report:

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

Industry Response (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 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.

Attachment C

Operating Interval Restriction

Proposed Administrative Technical Specification:

5.5.9 Steam Generator Program

d. SG Inspection Interval - Inspection intervals for SG tubing shall not exceed the maximum intervals defined in the SG Program. Revisions to these maximum operating intervals require review and approval by the NRC staff. The maximum inspection intervals may be revised to incorporate changes approved generically by the NRC subject to the limitations and conditions set forth in the staffs approving document.

Proposed Inspection Interval Restriction (to be located outside of technical specifications):

Inspection intervals shall not exceed that supported by degradation and operational assessment demonstrating reasonable assurance that all tubes will continue to satisfy the performance criteria prior to the next scheduled SG inspection. Degradation assessments shall consider the potential for the initial site-specific occurrence of potential degradation mechanisms. Operational assessments shall consider all known degradation mechanisms at the site. In addition, the following inspection intervals shall not be exceeded except as approved by NRC:

a. All steam generators shall be inspected at the first refueling outage, or at the first refueling outage following steam generator replacement.

b. For plants where each steam generator was found to be inspection Category C-1 (as defined in Section 3.5 of the EPRI PWR SG Examination Guidelines, Revision 5) during its most recent inspection, at least one steam generator shall be inspected each 40 calendar months (rotating basis) or two refueling outages, which ever is greater.

c. For plants where any steam generator was found to be inspection Category C-2 or C-3 during its most recent inspection, all steam generators shall be inspected at the next refueling outage