

April 30, 2001

MEMORANDUM TO: Brian W. Sheron, Associate Director
for Project Licensing and Technical Analysis

R. William Borchardt, Associate Director
for Inspection and Programs

FROM: Jack R. Strosnider, Director */ra/*
Division of Engineering

SUBJECT: STEAM GENERATOR REVIEW GUIDANCE

In the steam generator action plan dated November 16, 2000, the NRC staff indicated that we would document the completion of each major milestone in the action plan with a memorandum or report from the lead division director to the associate directors in the Office of Nuclear Reactor Regulation. This memorandum documents completion of milestones 1.10 and 1.12 of the steam generator action plan.

Milestone 1.10

Milestone 1.10 deals with the NRC treatment of licensees' summary reports of their steam generator eddy current inspection results. A number of issues were raised by the Office of the Inspector General (OIG) and the Indian Point 2 (IP2) lessons learned task group including the need for submission of this report, the content of the report, the purpose of the report, and the protocol for the staff's review of the report (Attachment 3 and pages 4 and 5 (bottom and top) of the staff's review of the OIG Report¹ and IP2 lessons learned task group recommendation No. 6c). We have determined that these reports provide useful information, and the Technical Specification (TS) requirement that they be submitted should be retained. Although additional information could be provided by the licensees in these reports and the timing for submission could be improved, we would not be able to impose these new requirements onto licensees in accordance with the requirements of 10 CFR Part 50 Section 109. Even if new requirements were developed and imposed by the NRC, it would not be an efficient use of our resources given the NRC's progress on its review and endorsement of NEI 97-06, the industry initiative on Steam Generator Program Guidelines. The NEI 97-06 framework addresses many of the shortcomings in the current TS reporting requirements by providing consistent guidance on the content of and more appropriate timing for the submittal of these steam generator inspection summary reports. When the framework is in place, licensees will be required to submit the

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¹Memorandum from William D. Travers, Executive Director for Operations, to the Commission dated November 3, 2000, "Staff Review of OIG Report on the NRC's Response to the Steam Generator Tube Failure at Indian Point 2 and Related Issues"

results of their steam generator inspections if greater than 1% of the inspected tubes in any steam generator exceed the repair criteria. The reports are to be submitted within 120 days after the plant reenters Hot Shutdown conditions. The specifics of the report include the inspection scope, active degradation mechanisms identified, inspection techniques applied, general characterization of indications, number of tubes plugged or repaired, repair methods applied, total number and percentage of tubes plugged or repaired to date, effective plugging percentage for all plugging and tube repairs, and the condition monitoring results, including tube pulls and in situ pressure test results.

The primary objectives of the staff's review of these inspection summary reports are to (1) support staff reviews of other types of licensee submittals such as license amendments, (2) confirm that licensees' steam generator tube inspection programs are in accordance with NRC regulations and industry guidelines, (3) provide background information to facilitate the exchange of information in conference calls with licensees conducted during steam generator tube inspection outages, and (4) provide background information for regional inspector use in inspection preparation. The staff will review all of these reports when they are received although the depth of our review will vary from plant to plant depending on the condition of that plant's steam generators. The new emphasis on staff review of the inspection summary reports is a change from our previous practices and reflects findings discussed in the Office of the Inspector General (OIG) report on the IP2 event as well as recommendations from the IP2 lessons learned task group. We estimate that this change in practice will "cost" approximately 0.75 FTE initially and 0.6 FTE after NEI 97-06 is in place.

Milestone 1.10 also involved reassessing the NRC treatment of what are referred to as "outage conference calls." For many years, NRR's technical review staff with the primary responsibility for reviewing steam generator related issues has teleconferenced with licensees during the outage season to discuss steam generator activities such as inspection plans and results. These conference calls have proven themselves invaluable in identifying potential weaknesses in licensees' inspection programs as well as identifying generic steam generator issues. The lessons learned task group also recognized the effectiveness of these conference calls and recommended that the staff consider incorporating these conference calls into the reactor oversight program (ROP). The staff explored this recommendation with both headquarters and regional personnel. The consensus was that the headquarters-related, highly specialized nature of the outage conference calls make them ill-suited for incorporation into the ROP.

Through our exploration of how these conference calls "fit" into the regulatory process, the staff found that the calls can best be considered as part of NRR's review of licensees' summary reports of their steam generator eddy current inspection results. We use the conference calls during outage season to gain timely information about the critical aspects of the licensee's steam generator tube inspection results. The staff focuses these conference calls on the most critical aspects because we recognize and are sensitive to the fact that the licensee is in an outage. When the inspection summary reports are subsequently submitted, the staff will review these reports to confirm that the inspection results and activities were consistent with our understanding from the conference call. We will also use this report to perform a more complete review of all the steam generator inspection results. Our review of the inspection summary reports and summaries of the conference calls will be provided to each licensee.

We have determined that we need to better define the procedure for the conduct of outage conference calls and the review of inspection summary report reviews. We also need better documentation of these calls and reviews than has been practiced in the past. Therefore, we plan to implement the following, beginning with the next major outage season (fall 2001):

For those plants that NRR identifies for conference calls:

1. The project manager opens a TAC for the plant under PA code 115, other licensing tasks.
2. The project manager sends a letter to the licensee requesting the conference call, including a list of discussion areas.
3. NRR staff conduct the conference call and provide a brief summary of the call to the project manager for docketing.
4. Subsequent to the conference call, NRR staff receive and review the licensee's inspection summary report of their steam generator eddy current inspection results. Our review will be documented and provided to the licensee.
5. Upon completion of NRR staff review, the project manager closes the TAC.

For those plants NOT identified for conference calls:

1. The project manager opens a TAC for the plant under PA code 115, other licensing tasks, upon receipt of the licensee's inspection summary report of their steam generator eddy current inspection results.
2. NRR staff review the summary report. Our review will be documented and provided to the licensee.
3. Upon completion of NRR staff review, the project manager closes the TAC.

More detailed review guidance for the inspection summary reports and outage conference calls are provided in the attached review guidance, discussed below.

Milestone 1.12

Milestone 1.12 involves the evaluation of the need for formal written guidance for technical reviewers conducting steam generator license amendment reviews (IP2 lessons learned task group recommendation No. 5c and 6a). We agree with the task group recommendation regarding the need for written review guidance. The guidance is attached and is effective immediately. The review guidance is intended for technical reviewers as an aid in guiding them through a review to ensure major areas receive appropriate focus. The guidance is not prescriptive because such guidance (1) cannot address every situation and may result in the reviewer overlooking important aspects of the submittal and (2) could become outdated as soon as the technology or state-of-the-art changes or new degradation issues arise. In addition, tube integrity involves many elements including prevention (e.g., water chemistry), mitigation (e.g., stress relieving), and repair (e.g., sleeving). Given these various defense-in-depth measures for addressing tube integrity, it is not practical to specify all combinations of an acceptable program. However, it is practical to provide written guidance on the engineering principles of ensuring tube integrity that should be considered in a review.

It should be emphasized here that written guidance for staff technical reviewers cannot be relied upon to prevent steam generator tube failures such as the one that occurred at IP2 in February 2000. The root cause of that failure has been attributed to inadequate licensee action in response to poor eddy current data quality. As discussed in the November 3, 2000, memorandum from W. D. Travers to the Commission, it is not practical for the staff to conduct comprehensive eddy current data reviews to ascertain the inspection quality. The responsibility for performing effective steam generator inspections is, and should remain, the licensees'.

The attached review guidance contributes to the NRC's four performance goals of maintaining safety, reducing unnecessary burden, improving efficiency and effectiveness, and improving public confidence. Specifically, the guidance will contribute to maintaining safety by addressing the range of safety issues involved in ensuring tube integrity. Because this guidance provides review direction in a single location and anticipates issues that need to be addressed, reviewer efficiency and effectiveness will be improved. The guidance is expected to reduce unnecessary burden by focusing reviews on the essential issues. The implementation of this guidance and the contribution of this guidance to maintaining safety assist in increasing public confidence. Also, the guidance underscores the importance of keeping the public informed of issues considered in plant specific reviews.

In summary, the attached written guidance is responsive to the IP2 lessons learned task group recommendations and the OIG comments and observations on these issues. It is our intent to keep this review guidance as a living document, to be modified, as seen necessary, by the steam generator technical reviewers with appropriate supervision at the branch level. We specifically plan to review the need for any revisions after the NEI 97-06 revised regulatory framework is implemented. Controls will be placed on the review guidance to ensure consistency and completeness and to document future revisions. The staff will also explore the possibility of incorporating this guidance into the Standard Review Plan (SRP) or another, similar vehicle. Comments on this guidance are welcome and should be addressed to Stephanie Coffin, NRR/DE/EMCB, 415-2778.

Attachment: As stated

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STEAM GENERATOR REVIEW GUIDANCE

The following review guidance is general in nature and should only be used as a guide rather than a checklist of items to review. The guidance is purposefully not prescriptive because such guidance may result in the reviewer overlooking important aspects of the submittal and also because such guidance could become outdated as soon as the technology or the state-of-the-art changes or new degradation issues arise. It must be acknowledged here that some steam generator-related submittals are unique and complex and as such do not lend themselves well to following written review guidance. Complicating this situation is the fact that reviews of these types of submittals oftentimes need to rely heavily on engineering judgement and that there are various review approaches that could be taken (and be successful). Therefore, in certain situations it may not be necessary for a reviewer to fully address each area discussed in the following guidance. Regardless of the specific approach taken in the review, reviewers are challenged to make sure that the licensee understands all the degradation occurring in their steam generators and is managing it. Reviewers will need to do a “sanity check” by asking questions such as: Does the licensee’s proposal, program inspection results make sense in light of prior plant and industry experience? Is there something new, unexpected, or not well understood occurring? If so, is the root cause understood and have appropriate corrective actions been taken and confirmed to be effective? Additional situation-specific areas to be explored are included in this guidance. But remember: **DO NOT USE THESE GUIDELINES AS A CHECK LIST!**

All licensee submittals must provide adequate information so that the staff can reasonably conclude that steam generator tube structural and leakage integrity will be maintained for the operating interval between inspections. To demonstrate tube integrity, licensees must periodically inspect their steam generator tubes, correlate an inspection parameter(s) to a structural and/or leakage parameter, and evaluate tubes accepted for continued service for the operating interval between inspections. Additionally, there may be risk implications related to the submittal which may or may not be understood by the licensee. Depending on the submittal, the reviewer will need to review each of these aspects. In addition, the reviewer will need to document the review and evaluate the appropriateness of any proposed modifications to the TS. In many cases, engineering judgment will be relied upon in assessing the overall adequacy of the submittal.

The first portion of the review guidance is applicable to all types of licensee submittals and addresses the following major areas:

- Review Resources
- Evaluation of an Inspection Program
- Evaluation of Structural and Leakage Databases
- Evaluation of the Criteria Used to Accept Tubes for Continued Service
- Risk Implications
- Documenting the Review
- Modifications to the Technical Specifications

The second portion of the review guidance provides more specific guidance for the various types of steam generator tube integrity reviews:

Power Uprates
Alternate Repair Criteria (F*, W*, L*, GL 95-05, PWSCC at dents, B&W S/N criteria)
Re-Roll Amendments
Inspection Interval Extensions
Sleeving Amendments
Steam Generator Replacements
GL 95-05 90-Day Reports
Relaxation of Tube Pull Requirements for GL 95-05
Licensees' Inspection Summary Reports
Steam Generator Outage Conference Calls

The third and last portion of the review guidance contains numerous references which reviewers should, in general, be aware of.

GENERIC REVIEW GUIDANCE FOR STEAM GENERATOR TUBE INTEGRITY REVIEWS

1. Review Resources

For all types of reviews, the reviewer should obtain and review examples of previous, similar reviews, if available, as well as recent steam generator inspection summary reports submitted by the licensee in accordance with their technical specifications.

During the review process, the reviewer should explore and discuss findings and issues related with the submittal with other NRC staff, as needed. This would include other reviewers within NRR's Component Integrity & Chemical Engineering Branch, Reactor Systems Branch, and the Probabilistic Safety Assessment Branch. Other resources for the reviewer include program managers for SG research, NRR consultants, research engineers at various national laboratories, and regional inspectors. Management of course should be kept informed of these findings and issues, as appropriate. This is a useful practice to engage in for any type of review, but it is particularly important to take advantage of the resources available in the agency if the reviewer identifies an incomplete application, or if the submittal contains new information or is particularly complex or controversial.

For licensing actions, reviewers should follow the guidance in NRR Office Letter No. 803, "License Amendment Review Procedures," particularly with respect to technical staff responsibilities in general and specifically with guidance for requests for additional information and risk-informed licensing action guidance.

Additional guidance related to risk implications can be found in NRC Regulatory Issue Summary (RIS) 2001-02, "Guidance on Risk-Informed Decisionmaking in License Amendment Reviews." RIS 2001-02 provides guidance on the review of a risk-informed submittal. It also highlights the need for reviewers to assess *non-risk-informed* submittals to identify if there are any unaddressed, potentially significant risk effects that approval of the licensing action or activity could precipitate.

2. Evaluation of an Inspection Program

Refer to Inspection Procedures 71111.08, "Inservice Inspection Activities" and 50002, "Steam Generators."

Identify the degradation modes the tubes are susceptible to. This determination should be based on operating experience from the plant and from plants with similar tube materials and fabrication techniques (e.g., radius of the Row 1 and 2 U-bends, type of tubesheet expansion transition). However, other factors should be considered such as T-hot, water chemistry excursions, and operating time (EFPY).

Ensure that the licensee is using, at a minimum, EPRI-qualified inspection techniques for detecting and sizing degradation to which the SG tubes are susceptible to or is using the best available technique for detection if no qualified technique exists.

If the inspection techniques are generically qualified, ensure that the licensee has assessed the similarity between the data in the qualification program and the data obtained at their site (e.g., presence of copper, noise levels, etc.). Investigate the need for tube pulls to confirm the nature of degradation.

Confirm that the licensee is following the industry guidance with respect to the qualification of inspection techniques and the qualification of analysts. If the inspection technique used is not applied within the acceptable range for the essential variables, confirm that the licensee assessed the significance of the changes. For example, if the applied probe speed is outside the range of the values in the technique qualification, confirm that the licensee has assessed the effects of this, especially on data quality and degradation detectability.

Determine if the inspection parameters are tied to burst and leakage correlations. If so, confirm that the inspection data are gathered consistently (e.g., acquisition and analysis). For example, confirm the need for, and use of, a transfer standard to account for differences in calibration standards from plant-to-plant.

When assessing tube structural and leakage integrity, confirm that the licensee has quantified or considered all of the uncertainties associated with the technique used. Ensure the licensee assessed the entire "system." For example, in qualifying a technique the data are frequently scrutinized by many experts and then the "final call" is made. This does not reflect the typical production analysis protocol where data from thousands of tubes are analyzed on a rigorous schedule. Ensure both the uncertainty of the technique and the analysis are addressed.

Confirm that the licensee has identify the cause of, or potential for, new degradation and has taken appropriate corrective actions and has confirmed the effectiveness of such actions in accordance with 10 CFR Part 50, Appendix B, Criterion XVI.

Consider the need for Regional support to confirm specific aspects of the inspection program.

Consider the need to obtain "raw" eddy current inspection data to confirm specific aspects of the inspection program. It is expected that this will not be commonly done, but reviewers should be aware that both NRR and RES have resources available to review limited amounts of raw eddy current data.

3. Evaluation of Structural and Leakage Databases - Licensees frequently propose two types of models for the structural and leakage integrity assessments: theoretical and empirical. In some cases a combination of models is used. Below is some general guidance for assessing such models.

Confirm that the theoretical models are either benchmarked or that they are reasonably based on operating experience, engineering judgment, or other conservatisms in the overall approach for assessing tube integrity.

Confirm that data upon which the models are based are appropriately and consistently obtained with qualified procedures.

Confirm that empirical models are statistically valid. Confirm that all available data are included or that a set of exclusion criteria are applied consistently to all data. The exclusion criteria should be able to be applied with little or no judgment.

Confirm that uncertainties in the models are properly accounted for. For empirical models this would include normal data scatter. For both types of models, ensure that material variability is accounted for.

For models that are based on databases that are continually updated (e.g., EPRI's ODSCC database in support of Generic Letter 95-05), confirm that the licensee is actively engaged in this process, particularly with respect to assessing potentially adverse effects of the addition of new data, in accordance with 10 CFR Part 50, Appendix B, Criterion XVI.

Consider the need for Research support to confirm specific aspects of the tube integrity models.

4. Evaluation of the Criteria Used to Accept Tubes for Continued Service

Confirm that the licensee is plugging all tubes with degradation exceeding the repair limits.

Confirm that the licensee is plugging tubes upon detection of indications if the inspection technique used was not qualified for sizing (and an alternate repair criteria does not apply). Confirm that the licensee has assessed the structural and leakage integrity of the tubes with the indications via in situ pressure testing or other analysis.

Confirm that the licensee has assessed structural and leakage integrity via in situ pressure testing for those tubes with indications that exceed in situ screening criteria. Confirm that the in situ pressure test results are adjusted for temperature and other loading considerations (e.g., circumferential indications).

For condition monitoring and operational assessments:

Confirm that the licensee has addressed all forms of degradation which it has observed or could potentially observe over the next operating interval and has taken appropriate inspection action. If the licensee relies on a predictive type analysis to determine when specific forms of degradation will begin to occur in the SGs, assess the applicability and reliability of such an analysis.

One of the major premises in these assessments is that the operating conditions (water chemistry, T-hot, ...) from one cycle to the next are similar. Confirm these expectations. If not, ensure the licensee has assessed the impact.

Evaluate the basis for growth rate distributions and NDE uncertainty models. If the degradation was detected for the first time during an inspection, confirm that the licensee has addressed the uncertainty associated with growth rates (i.e., when the degradation initiated; at the beginning of the cycle or sometime during the cycle). Confirm that the licensee understands the root cause of new degradation,

unexpectedly high growth rates, unexpectedly high numbers of new indications, etc. and has taken appropriate corrective actions in accordance with 10 CFR Part 50, Appendix B, Criterion XVI.

Confirm that the licensee has used conservative values for growth, NDE uncertainty, and material properties in their analysis.

Confirm that the licensee has accounted for uncertainties in their leakage and burst models.

Confirm that the licensee has determined all tubes will meet required loadings at the end of the next operating interval. Confirm that the licensee has assessed all loading conditions including vibratory loads, LOCA plus SSE, SLB plus SSE, etc. (see Regulatory Guide 1.121 and ASME Code). Consider that the accident loadings on tubes in a once-through steam generator are different from those in a recirculating steam generator.

If probabilistic analysis are used, evaluate the appropriateness of the probability of detection and all other input models. Determine the need for the licensee to benchmark their models based on data observed in prior cycles.

Confirm that the assumptions are backed up with data or that their accuracy can be assessed on an on-going basis. For example, if the licensee indicates a “worn probe” will not miss “large” defects and has some data to support this, consider having them confirm this assumption on an on-going basis.

If licensee relies on a secondary support structure in a tube integrity analysis, confirm the licensee knows the integrity of this structure (e.g., tube support plate).

Consider the need for Regional support to confirm specific aspects of the licensee’s criteria for accepting tubes for continued service.

5. Risk Implications

Reviewers need to be sensitive to the risk implications of vulnerabilities arising from new degradation mechanisms, repairs, or alternate repair criteria. Certain situations can arise where design basis conditions may be met throughout the operating cycle but may have beyond design basis risk implications. Examples may include the application of new steam generator materials that exhibit poor mechanical properties under high temperature conditions which introduces new vulnerabilities at these high temperature conditions and proposed alternate repair criteria that would leave through wall cracks in service in the freespan region of steam generator tubes.

If the licensee relies on a submittal that is risk-informed or has risk implications, consult the Probabilistic Safety Assessment Branch. Additional Guidance is available in NRR Office Letter No. 803, “License Amendment Review Procedures,” and in RIS 2001-02, “Guidance on Risk-Informed Decisionmaking in License Amendment Reviews.”

6. Documenting the Review

Succinctly describe the basis for the conclusion addressing each of the applicable review areas (inspection, correlations, tube integrity evaluation). It is not necessary to repeat all of the technical information provided by the licensee.

Clearly indicate “weak areas” in the licensee’s submittal and indicate the basis for your conclusion especially if the basis for your conclusion is different than the licensee’s.

Reviewers need to be sensitive to the need to make information on reviews available to the public. For example, summaries of conference calls associated with license amendment reviews or other types of reviews need to be provided to the project manager for docketing.

7. Modifications to the Technical Specifications

Confirm the logic and adequacy of the licensee’s proposed modifications to the TS including inspection and reporting requirements. Refer to other similar reviews as a guide for the type of requirements.

Determine the need for reporting requirements (either in the TS or as part of the methodology) for confirming critical assumptions on an on-going basis.

Determine the need to reference the topical report with revision number in the TS.

REVIEW GUIDANCE FOR SPECIFIC TYPES OF STEAM GENERATOR TUBE INTEGRITY REVIEWS

Several of the different types of steam generator tube integrity reviews are listed below along with specific issues that should be evaluated or considered as part of the review.

Power Upgrades

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, and robustness of inspections.

Evaluate the potential for increased degradation due to higher temperatures and higher flows.

Ensure that the licensee has evaluated the potential for fluidelastic instability, fatigue of tubes, etc.

Confirm that the licensee has evaluated the potential for increase in tube wear at support structures and near loose parts.

Confirm that the licensee has assessed the effects on repair limits and existing operational assessments.

For first of a kind reviews, consult with reviewers in the Mechanical and Civil Engineering Branch and Reactor Systems Branch to identify and assess changes associated with the submittal (e.g., increased pressures, temperatures, flow rates) that may be significant with respect to tube integrity.

Alternate Repair Criteria (F*, W*, L*, GL 95-05, PWSCC at dents, B&W S/N criteria)

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, and robustness of inspections.

Evaluate the inspection requirements for acceptability (e.g., initial inspection scope, expansion criteria, eddy current test technique...)

Evaluate the databases upon which the ARC is based. Confirm that the data in the databases are consistently gathered from plant-to-plant, confirm that the burst and leakage testing was performed consistently and that similar definitions of burst and leakage are used.

Evaluate how structural and leakage integrity is assured.

Evaluate how tubes are accepted for continued service.

Ensure that the new TS operating leakage limit for primary to secondary leakage from the SGs is, at a minimum, 150 gpd/SG. Ascertain whether the licensee is implementing an administrative leakage limit of 75 gpd/SG in accordance with the EPRI guidelines. Consider other factors that may require imposing leakage limits less than these amounts.

If the submittal is risk-informed, or if the submittal requires additional review for risk implications, consult the Probabilistic Safety Assessment Branch and additional guidance as described earlier in the first section of this guidance under “Risk Implications.”

Re-Roll Amendments

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, robustness of inspections, and degradation in previous re-rolls (if applicable).

Confirm that tubes can withstand required pull-out loads as a result of normal and accident thermal and pressure loads. Confirm that the licensee addressed tubesheet bowing.

Confirm that leakage in the event of postulated accidents will be within required values.

Confirm that the licensee includes this leakage in any assessments of leakage integrity for other alternate repair criteria.

Confirm that the licensee has a methodology for assessing the adequacy (e.g., positioning) of the re-rolls (e.g., process control parameters, post-roll inspection).

Ensure that the new TS operating leakage limit for primary to secondary leakage from the SGs is, at a minimum, 150 gpd/SG. Ascertain whether the licensee is implementing an administrative leakage limit of 75 gpd/SG in accordance with the EPRI guidelines. Consider other factors that may require imposing leakage limits less than these amounts.

Use the “generic review guidance” provided in the first section of this document with respect to the review of inspection, databases, and tubes accepted for continued service.

If the submittal is risk-informed, or if the submittal requires additional review for risk implications, consult the Probabilistic Safety Assessment Branch and additional guidance as described earlier in the first section of this guidance under “Risk Implications.”

Inspection Interval Extensions

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, and robustness of inspections.

Evaluate past inspection results to determine the basis for extension request.

Confirm that the licensee had identified all active degradation mechanisms affecting the tubes consistent with plant and industry wide operating experience and has implemented an appropriate inspection program in response to these mechanisms.

Confirm the “similarity” between operating intervals to ensure operational assessment assumptions are valid. Confirm that no extreme chemical excursions have occurred which could affect steam generator tube integrity analysis.

Evaluate the operational assessment for acceptability.

Confirm if the SGs were in a properly controlled layup during extended shutdown and that water chemistry controls satisfy EPRI primary and secondary side chemistry guidelines.

If the submittal is risk-informed, or if the submittal requires additional review for risk implications, consult the Probabilistic Safety Assessment Branch and additional guidance as described earlier in the first section of this guidance under “Risk Implications.”

Sleeving Amendments

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, and robustness of inspections.

Confirm that the sleeving process will ensure an adequate bond to the tube. An adequate bond refers to the sleeve being able to withstand the required loadings (including cyclic loadings) on the sleeve per Regulatory Guide 1.121 and the ASME Code Section III requirements and acceptance criteria.

Evaluate the materials of construction of the sleeve for acceptability (e.g., corrosion resistance, Code acceptance). Ensure that the licensee addressed differential thermal expansion.

Confirm that the post sleeve inspection technique confirms an adequate bond.

Review the corrosion test results regarding the integrity of the sleeve-to-tube joint.

Evaluate the sleeve repair limits per the “generic review guidance” provided in the first section of this document for inspections and development of repair criteria.

Confirm the leakage integrity analysis for the sleeves.

Evaluate the post-sleeve installation inspection requirements.

Ensure that the new TS operating leakage limit for primary to secondary leakage from the SGs is, at a minimum, 150 gpd/SG. Ascertain whether the licensee is implementing

an administrative leakage limit of 75 gpd/SG in accordance with the EPRI guidelines. Consider other factors that may require imposing leakage limits less than these amounts.

Confirm that a separate sleeve inspection table pursuant to EPRI examination guidelines is included in the TS.

If the submittal is risk-informed, or if the submittal requires additional review for risk implications, consult the Probabilistic Safety Assessment Branch and additional guidance as described earlier in the first section of this guidance under “Risk Implications.”

Steam Generator Replacements

Ensure that all alternate repair criteria and repair techniques not based on the “new” design are removed from the TS. Ensure that all references to “repair” are removed.

Ensure that the new TS operating leakage limit for primary to secondary leakage from the SGs is, at a minimum, 150 gpd/SG. Ascertain whether the licensee is implementing an administrative leakage limit of 75 gpd/SG in accordance with the EPRI guidelines. Consider other factors that may require imposing leakage limits less than these amounts.

Ensure that the proposed preservice and inservice inspection criteria and frequency meet the latest revision of the EPRI SG Examination Guidelines. Ensure that there is no deviation from Improved Standard TS wording.

Reference 56 provides additional guidance relative to SG replacements.

GL 95-05 90-Day Reports

Evaluate atypical results from tube pulls (e.g., missed indications, atypical morphology, etc.). Confirm that the licensee identified the root cause of such atypical results, assessed their significance, identified the root cause(s) and took appropriate corrective actions.

Evaluate non-conservative projections of end-of-cycle conditions. The end-of-cycle voltage distribution should be conservative in terms of the number and size of indications. If not, confirm that the licensee identified the root cause(s), assessed their significance, and took appropriate corrective actions.

Evaluate the impact of other forms of degradation being observed at tube-to-tube support plate intersections (e.g., axial and/or circumferential PWSCC and/or circumferential ODSCC) on inspection requirements and on the validity of the measured voltages.

If alternate probe wear criteria is implemented, ensure that the licensee assesses adequacy of technique per the generic approval document, Reference 57.

Reference 58 provides additional review guidance relative to GL 95-05 90-day reports.

Relaxation of Tube Pull Requirements for GL 95-05

Reference 59 provides review guidance relative to relaxation of tube pull requirements for GL 95-05.

Licenseses' Inspection Summary Reports

The primary objectives of the staff's review of the inspection summary reports are to (1) support staff reviews of other types of licensee submittals such as license amendments, (2) confirm that licensees' steam generator tube inspection programs are in accordance with NRC regulations and industry guidance, (3) provide information to facilitate the exchange of information in conference calls with licensees conducted during steam generator tube inspection outages, and (4) provide information for regional inspector use in inspection preparation. The staff will review all of these reports when they are received although the depth of the review will vary from plant to plant depending on the condition of that plant's steam generators.

The outage conference calls (discussed in the next section of this review guidance) support our review of the inspection summary reports. We use the conference calls during outage season to gain timely information about the most critical aspects of the licensee's steam generator tube inspection results. The staff focuses these conference calls on the most critical aspects because we recognize and are sensitive to the fact that the licensee is in an outage. When the inspection summary reports are subsequently submitted, the staff reviews these reports to confirm that the inspection results and activities were consistent with our understanding from the conference call. We also use this report to perform a more complete review of all the steam generator inspection results. The review of the inspection summary reports are to be provided to each licensee.

Reviewers should be aware that currently these reports vary considerably and may not contain sufficient information to consider the recommendations that follow. These reports are expected to be substantially more complete after NEI 97-06 is implemented.

Confirm that the inspections performed were in accordance with the TS. Confirm that the licensee inspected for all potential forms of degradation and is following, at a minimum, industry guidance (e.g., NEI 97-06 and the associated EPRI guidelines).

Ensure that all inspection results were classified as C-1, C-2, or C-3 and that inspections were expanded and tubes repaired as required.

Confirm that the licensee fully assessed new forms of degradation observed in their steam generators, identified root cause(s) and has taken appropriate corrective actions. Be aware that licensees may not explicitly identify new forms of degradation in their reports.

Confirm that the licensee repaired and assessed tubes per the "generic review guidance" provided in the first section of this document.

Confirm information that was obtained in the outage conference call associated with the inspection summary report.

Steam Generator Outage Conference Calls

For many years, NRR's technical review staff with the primary responsibility for reviewing steam generator related issues has teleconferenced with licensees during the outage season to discuss steam generator activities such as inspection plans and results. These conference calls have proven themselves invaluable in identifying potential weaknesses in licensees' inspection programs as well as identifying generic steam generator issues.

The outage conference calls support our review of the inspection summary reports (discussed in the preceding section of this review guidance). We use the conference calls during outage season to gain timely information about the most critical aspects of the licensee's steam generator tube inspection results. The staff focuses these conference calls on the most critical aspects because we recognize and are sensitive to the fact that the licensee is in an outage. A more complete review of the outage inspection activities occurs when the staff reviews the inspection summary report from the licensee.

The timing for these conference calls is ideally when the licensees are about 75% complete their eddy current inspection and analysis. This timing balances the desire to obtain the latest inspection results with the ability to comment on the licensee's inspection activities such as in situ pressure testing and tube plugging before such activities take place.

Contact regional inspector to ensure they are aware of the conference call.

Review the inspection summary reports from prior outages to become familiar with the overall condition of the steam generator tubes, trends in degradation types and growth rates, and robustness of inspections.

Review previous conference call summaries.

Typical areas of discussion include:

Primary to secondary leakage prior to shutdown.

Results of primary and/or secondary side hydrostatic and/or leak tests.

For each steam generator, a general description of areas examined; include expansion criteria and specify type of probe used in each area.

For analyzed EC results, describe bobbin indications (those not examined with RPC) and RPC/Plus Point/Cecco indications. Include the following information: location, number, degradation mode, disposition, and voltages/depths/lengths of most significant indications.

Description of repair/plugging plans.

Discussion of previous history; "look backs" performed; consideration of similar plants' experiences.

Discussion of new inspection findings, including loose parts indications. Discussion of root cause evaluation and corrective actions taken in response to these findings.

Description of in-situ pressure test plans and results; include tube selection criteria, test pressure plans, test configuration.

Describe tube pull plans and preliminary results; include tube selection criteria and evaluation plans.

Assessment of tube integrity for previous operating cycle.

Assessment of tube integrity for next operating cycle.

Provide schedule for steam generator-related activities during remainder of current outage.

Discuss what steps have been taken, or will be taken, in response to recent generic communications. For example, after issuing the RIS 2000-22 on the events surrounding the Indian Point Unit 2 tube failure, licensees should include a discussion of the actions that are taken in response to identifying a new degradation mechanism, the actions taken to ensure that data noise levels are acceptable, and how data quality issues are addressed, including any applied data quality criteria.

For any identified issues, failures, nonconformances, deviations, etc., discuss how the licensee applied its 10 CFR Part 50, Appendix B program to address these.

Consider the need to obtain "raw" eddy current inspection data. It is expected that this will not be commonly done, but reviewers should be aware that both NRR and RES have resources available to review limited amounts of raw eddy current data.

Identify any issues identified during the conference call that warrant regional inspection follow-up and forward to the region.

The staff needs to be sensitive to the need for docketing that a conference call took place and any significant issues that arise from the conference call. To that end, reviewers should provide the appropriate project manager with a brief summary of the conference call and any materials provided by the licensee for docketing. If significant issues were discussed, these issues should also be identified and docketed.

Forward the documentation of the conference call to the region, as appropriate.

The staff needs to be sensitive to potential operating limitations or generic implications based on the inspection results discussed during these phone calls. Some information may require management briefings, Information Notice issuance, followup meetings at headquarters, etc., as appropriate.

Obtain the subsequent inspection summary report to confirm conference call discussions and to explore in more depth the steam generator inspection results (see guidance above for reviewing inspection summary reports).

STEAM GENERATOR TUBE INTEGRITY REFERENCES

Reviewers of steam generator tube integrity reviews should be aware of the following reference documents:

1. NEI 97-06, "Steam Generator Program Guidelines."
2. PWR Steam Generator Examination Guidelines, EPRI Report TR-107569.
3. PWR Primary-to-Secondary Leak Guidelines, EPRI Report TR-104788.
4. PWR Secondary Water Chemistry Guidelines, EPRI Report TR-102134.
5. PWR Primary Water Chemistry Guidelines, EPRI Report TR-105714.
6. Steam Generator Integrity Assessment Guideline, EPRI Report TR-107621.
7. In Situ Pressure Testing Guidelines, EPRI Report TR-107620.
8. U.S. NRC Regulatory Issue Summary 2000-22, "Issues Stemming from NRC Staff Review of Recent Difficulties Experienced in Maintaining Steam Generator Tube Integrity," November 3, 2000.
9. U.S. NRC Generic Letter 97-06, "Degradation of Steam Generator Internals," December 30, 1997.
10. U.S. NRC Generic Letter 97-05, "Steam Generator Tube Inspection Techniques," December 17, 1997.
11. U.S. NRC Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," August 3, 1995.
12. U.S. NRC Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes," April 28, 1995.
13. U.S. NRC Generic Letter 91-04, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24-Month Fuel Cycle," April 2, 1991.
14. U.S. NRC Bulletin 89-01, Supplement 2, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs," June 28, 1991.
15. U.S. NRC Bulletin 89-01, Supplement 1, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs," November 14, 1990.
16. U.S. NRC Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs," May 15, 1989.

17. U.S. NRC Bulletin 88-02, "Rapidly Propagating Cracks in Steam Generator Tubes," February 5, 1988.
18. U.S. NRC Information Notice 2000-09, "Steam Generator Tube Failure at Indian Point Unit 2," June 28, 2000.
19. U.S. NRC Information Notice 98-27, "Steam Generator Tube End Cracking," July 24, 1998.
20. U.S. NRC Information Notice 97-88, "Experiences During Recent Steam Generator Inspections," December 16, 1997.
21. U.S. NRC Information Notice 97-79, "Potential Inconsistency in the Assessment of the Radiological Consequences of a Main Steam Line Break Associated with the Implementation of Steam Generator Tube Voltage-Based Repair Criteria," November 20, 1997.
22. U.S. NRC Information Notice 97-49, "B&W Once-Through Steam Generator Tube Inspection Findings," July 10, 1997.
23. U.S. NRC Information Notice 97-26, "Degradation in Small-Radius U-Bend Regions of Steam Generator Tubes," May 19, 1997.
24. U.S. NRC Information Notice 96-38, "Results of Steam Generator Tube Examinations," June 21, 1996.
25. U.S. NRC Information Notice 96-09, Supplement 1, "Damage in Foreign Steam Generator Internals," July 10, 1996.
26. U.S. NRC Information Notice 96-09, "Damage in Foreign Steam Generator Internals," February 12, 1996.
27. U.S. NRC Information Notice 95-40, "Supplemental Information to Generic Letter 95-03, 'Circumferential Cracking of Steam Generator Tubes'," September 20, 1995.
28. U.S. NRC Information Notice 94-88, "Inservice Inspection Deficiencies Result in Severely Degraded Steam Generator Tubes," December 23, 1994.
29. U.S. NRC Information Notice 94-87, "Unanticipated Crack in a Particular Heat of Alloy 600 Used for Westinghouse Mechanical Plugs for Steam Generator Tubes," December 22, 1994.
30. U.S. NRC Information Notice 94-62, "Operational Experience on Steam Generator Tube Leaks and Tube Ruptures," August 30, 1994.
31. U.S. NRC Information Notice 94-43, "Determination of Primary-to-Secondary Steam Generator Leak Rate," June 10, 1994.

32. U.S. NRC Information Notice 94-05, "Potential Failure of Steam Generator Tubes Sleeved With Kinetically Welded Sleeves," January 19, 1994.
33. U.S. NRC Information Notice 93-56, "Weaknesses in Emergency Operating Procedures Found as a Result of Steam Generator Tube Rupture," July 22, 1993.
34. U.S. NRC Information Notice 93-52, "Draft NUREG-1477, 'Voltage-Based Interim Plugging Criteria for Steam Generator Tubes'," July 14, 1993.
35. U.S. NRC Information Notice 92-80, "Operation With Steam Generator Tubes Seriously Degraded," December 7, 1992.
36. U.S. NRC Information Notice 91-67, "Problems With the Reliable Detection of Intergranular Attack (IGA) of Steam Generator Tubing," October 21, 1991.
37. U.S. NRC Information Notice 91-43, "Recent Incidents Involving Rapid Increases in Primary-to-Secondary Leak Rate," July 5, 1991.
38. U.S. NRC Information Notice 90-49, "Stress Corrosion Cracking in PWR Steam Generator Tubes," August 6, 1990.
39. U.S. NRC Information Notice 89-65, "Potential for Stress Corrosion Cracking in Steam Generator Tube Plugs Supplied by Babcock and Wilcox," September 8, 1989.
40. U.S. NRC Information Notice 89-33, "Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs," March 23, 1989.
41. U.S. NRC Information Notice 88-99, "Detection and Monitoring of Sudden and/or Rapidly Increasing Primary-to-Secondary Leakage," December 20, 1988.
42. U.S. NRC Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," August 1976.
43. U.S. NRC Regulatory Guide 1.83, Revision 1, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes," July 1975.
44. U.S. NRC Draft Regulatory Guide DG-1074, "Steam Generator Tube Integrity," December 1998.
45. U.S. NRC, "Circumferential Cracking of Steam Generator Tubes," NUREG-1604, April 1997.
46. U.S. NRC, "Steam Generator Tube Failures," NUREG/CR-6365 (INEL-95/0383), April 1996.
47. U.S. NRC, "Steam Generator Operating Experience, Update for 1989-1990," NUREG/CR-5796, December 1991.

48. U.S. NRC, "Steam Generator Operating Experience, Update for 1987-1988," NUREG/CR-5349 (SAIC-89/1113), June 1989.
49. U.S. NRC, "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity," NUREG-0844, September 1988.
50. U.S. NRC, "Steam Generator Operating Experience, Update for 1984-1986," NUREG/CR-5150 (SAIC-87/3014), June 1988.
51. U.S. NRC, "Steam Generator Operating Experience Update for 1982-1983," NUREG-1063, June 1984.
52. U.S. NRC, "Steam Generator Tube Experience," NUREG-0886, February 1982.
53. U.S. NRC, "Summary of Tube Integrity Operating Experience with Once-Through Steam Generators," NUREG-0571, March 1980.
54. U.S. NRC, "Summary of Operating Experience with Recirculating Steam Generators," NUREG-0523, January 1979.
55. Memorandum from Brian Sheron, NRR, to John Larkins, ACRS, dated April 6, 1995, "ACRS Review of Generic Letter (GL) 95-xx, 'Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes.'"
56. Memorandum from C.D. Beardslee to W.H. Bateman, dated November 3, 1999, "Guidance for Materials and Chemical Engineering Branch (EMCB) Review of Steam Generator Replacement Packages."
57. Letters from B. Sheron (NRC) to A. Marion (NEI), dated March 18, 1996 and February 9, 1996.
58. Memorandum from C.D. Beardslee to S.M. Coffin, et al., dated October 29, 1997, "Guidance for Review of 90-Day Reports from Licensees Implementing a Voltage-Based Steam Generator Tube Repair Criteria per Generic Letter 95-05."
59. Letter from J.R. Strosnider (NRC) to D.J. Modeen (NEI), dated January 31, 2000, "Industry Recommended Steam Generator Tube Pull Program."
60. Memorandum from W.D. Travers to Commissioners, dated November 1, 2000, "Transmittal of the Indian Point 2 Steam Generator Tube Failure Lessons Learned Report."
61. NRR Office Letter 803, "License Amendment Review Procedures."
62. RIS 2001-02, "Guidance on Risk-Informed Decisionmaking in License Amendment Reviews."