

**Questions and Answers related to issuance of the  
Indian Point 2 Steam Generator Tube Failure Lessons-Learned Report**

**Q1. Why was the Indian Point 2 Steam Generator Tube Failure Lessons-Learned Report written?**

On February 15, 2000, a single tube in one of the four steam generators (SGs) at Consolidated Edison's (Con Ed's) Indian Point 2 (IP2) plant failed, leading to a transient and shutdown of the reactor. The tube failure consisted of a through-wall crack in one of the 3,260 tubes in one of the SGs that allowed reactor cooling water to flow through the crack into the steam generating side of the SG. The event resulted in a minor radiological release to the environment that was well within regulatory limits.

As part of the overall evaluation of the IP2 SG tube failure event, the NRC's Office of Nuclear Reactor Regulation (NRR) determined that the NRC staff should perform an evaluation of the lessons-learned from the event. The recommended approach and charter for this effort was provided in a memorandum from Samuel J. Collins to William D. Travers, dated May 24, 2000. This memo is publically available on the NRC web-site at <http://www.nrc.gov/NRC/REACTOR/IP/index.html> and in ADAMS at Accession No. ML003717020).

**Q2. Who wrote the report?**

The report was written by the Lessons-Learned Task Group. The Task Group was formed in accordance with the charter and consisted of staff from NRR, the Office of Research (RES), and Region I. Support was provided by the Office of General Counsel.

**Q3. What was the objective of the report?**

The objective of the lessons-learned report was to conduct an evaluation of the NRC staff's technical and regulatory processes related to assuring SG tube integrity in order to identify and recommend areas for improvements applicable to the NRC and/or the industry.

**Q4. What was the scope of the Task Group review?**

The scope of the Task Group review included technical issues and regulatory process issues related to assuring steam generator tube integrity. Conclusions and recommendations were developed based on reviews of documentation and discussions with NRC staff, NRC SG expert consultants, nuclear industry representatives involved in SG programs, and Con Ed staff. Public input was not sought as part of the Task Group effort based on the understanding that the report and other efforts would be integrated into an activity that would allow for input from a broad range of stakeholders.

The documentation that the Task Group reviewed included IP2 plant-specific SG documentation (e.g., Con Ed SG examination results, NRC inspection reports, NRC/Con Ed correspondence, IP2 Technical Specifications), NRC generic SG-related documents

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(e.g., Information Notices, Generic Letters, Regulatory Guides, NUREG's, inspection procedures), and nuclear industry generic SG-related documents (e.g., NEI, EPRI).

Technical issues that the Task Group reviewed included:

- 1) Risk insights associated with SG tube failure on both a plant-specific basis for the IP2 event and on a generic basis;
- 2) Con Ed's SG tube examination methods and practices;
- 3) Con Ed's SG condition monitoring and operational assessments;
- 4) Con Ed's implementation of SG regulatory requirements;
- 5) Con Ed's root cause evaluation associated with the tube failure event and the associated NRC Special Inspection Team report; and
- 6) Industry guidelines for SG inspection and assessment.

Regulatory process issues that the Task Group reviewed included:

- 1) The licensing review process associated with the NRC issuance of an IP2 license amendment that allowed a one-time extension of the SG inspection interval;
- 2) The NRC's oversight process and inspection program in the area of inservice inspection that relate to the SG tube examinations; and
- 3) The NRC's endorsement of industry guidelines.

The Task Group effort did not consider IP2 SG issues being addressed by other regulatory processes, such as a 2.206 petition or a differing professional opinion. Also, the Task Group review did not include NRC and Con Ed follow-up of the event that was not specifically related to SG tube integrity, such as emergency planning and degraded equipment issues. The Task Group did not evaluate Con Ed performance relative to regulatory requirements.

**Q5. What are the major conclusions/lessons-learned in the report?**

The major conclusions/lessons-learned reached by the Task Group include the following:

- 1) The IP2 tube failure resulted from degraded conditions allowed to exist in the SGs during the operating cycle. Con Ed's SG tube integrity program and QA program were deficient and did not detect the degraded conditions. These tube conditions presented a safety concern because of a reduction in safety margin and an increased risk of SG tube rupture during IP2's operating cycle 14.

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- 2) Communicating the safety significance of the IP2 event is difficult. Notwithstanding the loss of safety margin, IP2 is designed to mitigate the effects of SG tube failure or tube rupture, IP2 shut down safely following the tube failure, there was no measurable radioactivity offsite above normal background levels, and the event resulted in no adverse consequences to the public health and safety.
- 3) Weaknesses in Con Ed's implementation of the industry guidelines, combined with shortcomings in the technical guidance itself, contributed to the situation encountered at IP2.
- 4) During the 1997 SG eddy current examination by Con Ed, a defect caused by primary water stress corrosion cracking (PWSCC) was identified for the first time in a tube similar in type and location to the tube that failed at IP2, and Con Ed did not effectively evaluate the susceptibility of similar tubes to this degradation during the upcoming operating cycle.
- 5) During the 1997 SG examination, a form of degradation called tube denting was identified when restrictions were encountered as the eddy current probes were inserted into the U-bend portion of similar tubes. Con Ed did not evaluate the potential for, and significance of, this degradation.
- 6) During the 1997 examination, significant eddy current signal interference (noise) was encountered in the data obtained from a number of tubes similar to the tube that failed, and Con Ed's program was not adjusted to compensate for the noise, particularly when the new PWSCC defect was found in this area of the SG.
- 7) Based on Task Group discussions with NRR staff and outside expert contractors, there were different views on whether the flaw in the tube that failed in February 2000 could have been detected by the eddy current analysts during the 1997 SG examination due to problems with the noise in the data, absent further actions that should have been taken by Con Ed to compensate for high noise.
- 8) The significant conclusions from the Task Group review of the licensing review process associated with a Con Ed amendment request to extend the SG inspection interval are as follows:
  - a) There was an opportunity for Con Ed during preparation of the amendment request and subsequent response to an NRC request for additional information (RAI) to recognize the significance of a new degradation mechanism that was observed during the 1997 SG examination in a tube similar to the one that failed in February 2000 (PWSCC at tube apex in a small radius U-bend).
  - b) In hindsight, there were two opportunities during the amendment review process for the NRC staff to find inadequacies in Con Ed's operational assessment (i.e., during review of the RAI response and during review of

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the licensee's 1997 SG tube examination report). However, it is not clear to the Task Group if further follow-up in either one of these cases would have yielded a different result (e.g., denial of the amendment request).

- c) The IP2 SG tube failure approximately 8 months after the originally scheduled inspection date (i.e., less than the duration justified by the recapture of the 10 month wet lay-up period). Therefore, the SG inspection interval extension of approximately 2 months, associated with the issuance of the amendment, did not contribute to the tube failure event in February 2000. This conclusion is based on the fact that the tube failure took place in less than the number of effective full power days that was allowed between SG inspections. This is illustrated in the Appendix A timeline in the report.
  - d) While the staff used existing NRC review guidance in performing the review, no specific guidance exists for SG inspection interval extensions, especially how to consider previous inspection reports, or how to consider or reference the inspection program.
- 9) The significant conclusions from the Task Group review of the NRC's oversight process and inspection program in the area of inservice inspection that relate to the SG tube examinations are as follows:
- a) The NRC's baseline inspection program does not include guidance on the scope and depth of NRC's inspection of licensee's SG tube examinations.
  - b) The NRR telephone calls (outage phone calls) with the licensees during the licensees' SG tube examinations can be effective, but are not formally included in either the licensing or inspection process.
  - c) Risk-informed thresholds have not been established in the Reactor Oversight Process (ROP) for either the baseline inspection program or the performance indicators (PIs) to identify adverse trends in primary-to-secondary leakage that warrant increased NRC interaction.
  - d) Risk-informed thresholds are necessary in the ROP to identify those plants experiencing a level of SG tube degradation that warrants NRC interaction above the baseline inspection program. However, the means to accomplish this have not been established either through the PIs or the significance determination process (SDP).

**Q6. What are the major recommendations in the report?**

The Task Group review resulted in the development of 36 recommendations as shown in Table 9-1 of the lessons-learned report. The major areas addressed in the recommendations include the following:

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- 1) Con Ed must correct the deficiencies in its SG tube integrity program;
- 2) Industry should improve the EPRI guidelines;
- 3) Industry should improve the SG technical specifications;
- 4) Industry should improve the NEI 97-06 initiative;
- 5) The NRC should improve its SG oversight and inspection process;
- 6) The NRC should improve its licensing review process;
- 7) The NRC should assign a high priority to its review of the NEI initiative and the associated EPRI guidelines;
- 8) The NRC should issue a generic communication regarding SG tube integrity program guidance; and
- 9) The NRC should improve risk communication to the public.

Overall, the Task Group believes that the lessons-learned from IP2 are important relative to assuring SG integrity and that the industry initiative should expeditiously incorporate the lessons-learned into the regulatory framework.

**Q7. How will the recommendations be implemented?**

The staff is developing an integrated action plan that considers all the SG generic activities. The action plan will address the input of the lessons-learned report as well as generic activities the staff had underway prior to the IP2 tube failure, specifically the NEI 97-06 steam generator industry initiative. The action plan will be made publicly available upon its completion.

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- Q8. Since many of the recommendations deal with issues that apply to the nuclear industry generically, why does the NRC feel that it is safe for other pressurized water reactors to operate before the recommendations can be implemented?**

The staff has not been waiting for the results of the lessons-learned study to incorporate lessons learned from the IP2 SG tube failure in their review and inspection activities. Soon after the failure the staff requested that NEI take steps to ensure that lessons from IP2 would be addressed generically and factored into the fall 2000 SG inspections. NEI met with the staff on July 26, 2000, to discuss steps being taken and issued a letter to the NRC on October 6, 2000, that contains industry lessons-learned which were provided to PWR utilities for their action. The industry also took additional actions following the IP2 tube failure. Some of the plants with older SGs used the high frequency eddy current probe during inspections conducted last spring and this fall to help improve the inspections of the U-bend region of the tubes.

Also, the staff performs certain oversight functions to ensure that SG management programs are being implemented effectively. Specifically, the NRC performs on-site inspections and conducts phone calls with certain licensees in outages. Lessons-learned from the IP2 tube failure and related guidance for regional inspectors have been discussed during counterpart conferences between NRR and the regional inspectors and these inspectors have been focusing their baseline inservice inspections on SG issues related to the lessons from IP2. The NRR staff has continued to conduct phone calls with licensees to discuss the SG examination results and now asks licensees to discuss steps that they have been taking in response to the industry lessons-learned from the IP2 tube failure.

It should be noted the recommendations of the lessons-learned report concern many issues that are not new to the staff and the industry. Many of these issues are discussed in previously issued NRC staff documents, such as information notices, and in certain industry guidelines. The IP2 tube failure and the staff's lessons-learned report have resulted in an increased focus on the importance of improving the treatment of these issues in various guidelines and procedures. The framework for addressing some of these improvements is provided by the NEI 97-06 industry initiative that has been the focus of industry and NRC staff efforts during the past three years and that has already resulted in significant improvements in the industry SG management programs.

Finally, we should not lose sight of the fact that plants are designed and operated with defense-in-depth. Licensees follow tube inspection and maintenance procedures intended to ensure that safety margins against tube burst and leakage are maintained. Primary-to secondary leakage monitoring is continually performed to ensure that plants experiencing significant leakage are shut down. Also, plants are designed with safety systems to bring the reactors to a safe shutdown condition should a steam generator tube failure occur.

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- Q9. Did the report address the review done by the NRC's Office of Research (RES)? In addition, when will NRR formally respond to RES on the results of its review?**

Yes. Following the IP2 tube failure event, NRR requested RES to review the NRC safety evaluation associated with an IP2 license amendment that approved an extension to the SG inspection interval. RES provided the results of its review in a memorandum dated March 16, 2000. The Task Group Charter (see Q1) states that the results of the RES review were to be considered as part of the Task Group's effort. The Task Group considered the issues raised in the RES review as discussed in Sections 6.2, 6.4, 7.0, and 8.1 of the lessons-learned report.

There are no plans for a formal written response from NRR to RES on the results of the RES review, and none was required or expected by RES.

- Q10. Did the report address the inquiry done by the NRC's Office of the Inspector General (OIG)?**

Yes. On August 29, 2000, the OIG issued its event inquiry, "NRC's Response to the February 15, 2000, Steam Generator Tube Rupture at Indian Point Unit 2 Power Plant." The OIG had initiated this inquiry because of concerns from Congress and the public about the IP2 event. The Task Group addressed the findings of the OIG report related to SG issues as discussed in Sections 6.3 and 8.1 of the lessons-learned report.

- Q11. Is the report publically-available on the NRC web-site or in ADAMS?**

Yes. The lessons-learned report is publically available on the NRC web-site at <http://www.nrc.gov/NRC/REACTOR/IP/index.html> and in ADAMS at Accession No. ML003762242.

- Q12. Does the report change in any way the potential red finding related to Con Ed's 1997 SG inservice examinations as documented in the NRC's Special Inspection Report dated August 31, 2000?**

No. The Task Group reviewed the major aspects of the 1997 Con Ed SG examinations and the plans leading up to these examinations. These same activities were the subject of the NRC's Special Inspection Report dated August 31, 2000. The Task Group agrees that the inspection findings are of potential high significance, as proposed. The Task Group believes that the findings of the Special Inspection Team are reasonable and that corrective actions at IP2 should proceed in accordance with the ongoing inspection and enforcement process.

The Task Group's review of the risk insights related to the IP2 event concluded that the IP2 tube failure resulted from degraded conditions allowed to exist in the SGs during the operating cycle. Con Ed's SG tube integrity program and QA program were deficient and did not detect the degraded conditions. These tube conditions presented a safety

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concern because of a reduction in safety margin and an increased risk of SG tube rupture during IP2's operating cycle 14.

**Q13. Does the report change in any way NRC actions toward IP2 relative to the conclusions in the Special Inspection Report?**

No. The lessons-learned report does not in any way modify the conclusions of the Special Inspection Report. The licensee specific deficiencies identified in the Special Inspection Report and any further interactions between NRC and Con Ed relative to those deficiencies are being addressed under the NRC's oversight process.

**Q14. Most of the recommendations in the report are for the Industry and NRC. What does this mean?**

The lessons-learned report is not an "inspection report," and was meant to address numerous facets of SG inspection and oversight. The objective of the lessons-learned report was to conduct an evaluation of the NRC staff's technical and regulatory processes related to assuring SG tube integrity in order to identify and recommend areas for improvements applicable to the NRC and/or the industry. The recommendations for the industry apply to IP2 and also apply generically to other PWRs.

In addition to the generic industry recommendations, the lessons-learned report made one specific recommendation for Con Ed. Section 5.4 of the report recommends that Con Ed correct the deficiencies in its SG tube integrity program that led to the degraded SG condition during IP2 cycle 14. Otherwise, the long-term risk of steam generator tube rupture at IP2 could be affected.

**Q15. The report appears to find much fault with "industry guidelines". Was IP2 a victim of poor industry guidelines?**

Industry Guidelines are just that - guidelines. NRC regulations, in particular 10 CFR 50, Appendix B, require a licensee to take corrective actions for significant conditions adverse to quality. Therefore, even though industry guidelines could be improved to help assist a licensee in their tasks, lack of guidelines does not excuse a licensee from the requirement for timely and effective corrective actions for conditions adverse to quality.

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**Q16. What are the Task Group recommendations regarding the Technical Specification primary-to-secondary leakage limits given that the existing IP2 limits did not prevent the tube failure?**

As discussed in the lessons-learned report, IP2 Technical Specification (TS) Section 3.1.F.2a, Primary-to-Secondary Leakage, contains the operational leakage limits for the SG tubes. It establishes a limit of 0.3 gallons per minute (gpm), or 432 gallons per day (gpd) in any SG which does not contain tube sleeves, or 150 gpd for any SG that contains sleeves. The TS also requires that if the limit is exceeded, or if leakage from two or more SGs in any 20-day period is observed, the reactor shall be brought to cold shutdown within 24 hours. As indicated in the basis section of the TSs, the intent of such safety measures is to prevent small leaks from developing into larger ones and possible gross failure.

Section 4.5 of the NRC's Augmented Inspection Team (AIT) Report, dated April 28, 2000, states that following plant startup in October 1999, the leak rate in SG 24 appeared to vary from 2 to 4 gallons per day (gpd) but returned to pre-shutdown levels of 1.5 to 2.0 gpd through December 1999. Starting in January 2000, the leak rate slowly increased to about 3 to 4 gpd just prior to the tube failure on February 15, 2000. The leak rates observed prior to the event were significantly below the limit at which any mitigating action would need to be taken in accordance with the IP2 TSs.

The Task Group concluded that the IP2 TS limit on primary-to-secondary leakage did not provide pro-active indication of upcoming tube failure. The experience from the IP2 event where the SG leakage did not exceed the TS limit before a tube failed indicates that IP2 TS leakage limits, by themselves, are not always sufficient to prevent such a failure or provide meaningful indication of an impending failure. The Task Group recommended that the industry assess the adequacy of the TS regarding operational leakage limits.

Even if improvements can be made industry-wide to the TSs on leakage limits (and SG tube integrity programs in general), it is likely that tube failures and ruptures will occur in the future. Leakage monitoring is a defense-in-depth measure and it should not be expected to provide indication of all impending SG tube failures and ruptures.

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- Q17. The Executive Summary and Section 8.2 of the lessons-learned report discuss the phone calls held between the NRC and Con Ed during the 1997 outage to discuss the results of the licensee's SG tube examinations. The report states that some NRC staff members interviewed by the Task Group indicated that they had specifically asked Con Ed during the phone calls if any degradation in small radius U-bends had been identified and that there was no indication that the crack discovered in the tube similar to the tube that failed was discussed (tube R2C67 in SG24). Why isn't the NRC taking enforcement action against Con Ed for this apparent violation of 10 CFR 50.9, "Completeness and accuracy of information," or 10 CFR 50.5, "Deliberate misconduct?"**

Several phone calls were held between the NRC and Con Ed during the 1997 outage to discuss the IP2 SG examination results. However, no documentation was found by the Task Group that indicated at what point in the outage the NRC questioned Con Ed about degradation in small radius U-bends. It is also was not clear to the Task Group at what point in the outage the eddy current data was analyzed and that a determination was made by Con Ed that there was a crack in the apex of tube R2C67 in SG24. NRR's Division of Engineering has reviewed the information in the lessons-learned report and has referred this issue to the NRR Office Allegations Coordinator. The allegation review process will make the determination if there is a basis for enforcement action.