

Indian Point 2 (IP2) Steam Generator (SG) Tube Failure  
Lessons-Learned Task Group  
(TAC No. MA9163)

Task Group Notes - Discussion with Emmett Murphy on 6/29/00

Attendees: Scott Newberry, Louise Lund, Jimi Yerokun, Alan Rubin, Rick Ennis,  
Maitri Banerjee, Jack Goldberg

Background

Emmett was involved during the review and preparation of the Safety Evaluation (SE) approving the IP2 one-time extension of the SG inspection interval (IP2 Amendment No. 201, dated 6/9/99, TAC No. MA4526). Emmett is the technical lead for the SG group in EMCB.

Focus of Discussion

The focus of this discussion was to look at the licensing review process that was used for Amendment 201 and other related technical issues and determine if there are any lessons-learned.

Results

- 1) Are there any lessons-learned as a result of the IP2 event and the associated review that was performed for the SG inspection interval extension amendment?
  - The event emphasized the importance of data quality and the need to optimize plant procedures for performing eddy current testing.
  - It is important that the licensee personnel have adequate inhouse technical expertise on SG testing (in addition to contractors). The Con Ed inhouse staff is lacking in the understanding of basic fundamentals with regard to SG testing.
  - The industry probably needs automated data screening because some of the analysts that watch the data collection do not click on every possible indication on the strip chart for further review/analysis. This is probably due to the time factor involved with the examination process.
  - Con Ed and Westinghouse missed the significance of problems at U-bends.
  - Plants could benefit from site specific demonstration programs before getting into the examinations.
  
- 2) What was the technical complexity/safety significance of this license amendment request?

The requested change was not considered complex or safety significant. The extra 2 month extension was insignificant. The review for Amendment 201 was not worthy of applying significant resources. He would consider it safety significant if the license change would reduce safety margins. Fact that we have tube ruptures every few years does not indicate that we have a significant safety or risk problem. The significance of

J/102

the inspection interval extension was to recapture the time spent in unscheduled outage by extending the date for the required inspection by the time lost during the outage. The generators were in wet lay-up during the unscheduled outage, and there was precedent for granting this type of extension. If the plant had not shut down for the unscheduled maintenance outage, the tube would have ruptured during the normal operating cycle (24 months).

- 3) Did the SE reviewer have the proper level of experience to perform this review?

Emmett was aware the reviewer was not highly experienced in this technical area. However, the safety significance and complexity were such that the reviewer was appropriate. Emmett reviewed the SE but not the source material. He had no safety concerns during his SE review.

- 4) What guidance do technical reviewers use when reviewing a request to extend the SG inspection interval (e.g., NRC Regulations, SRP, industry standards)?

Since there is no SRP, draft Regulatory Guide DG-1074 is used as a benchmark, although since it is draft it has no official regulatory standing. The reviews basically are done such that the safety arguments convince the staff that SG tube integrity will be maintained.

- 5) Did schedule impact the depth of the review?

Although the application was received in December 1998, the EMCB review didn't really start until April 1999. RAI response was received in May and Amendment needed to be issued in June. The depth of the review was appropriate although the schedule did not allow a more intensive review. The depth of the review dictated that we shouldn't need to review the 1997 inspection results. Because of this, the apex location of the flaw was not in the perspective of the reviewer.

- 6) What are the technical considerations that must be evaluated for the restart SE?

The primary technical concern is threshold of detection of flaws in the U-bends. The licensee used high frequency probe but the detection capability is still not that great. Also, the high frequency probe can be used to improve the detection capabilities for primary water stress corrosion cracking because it is more sensitive to flaws towards the inner surface of the tube, but will not help detect flaws that originate at the outside diameter (outside diameter stress corrosion cracking). The licensee wants approval for 8.5 months even though SG replacement is planned by the end of the year. The staff has asked the licensee to provide a revised analysis that only considers the time that they will need until SG replacement. Need to have a safety margin of 3. The challenge is to demonstrate the safety margin will be maintained.

- 7) During the review process, did the staff have any concerns about the results of the 1997 inspection of the IP2 SGs?

The review was done with the assumption that the 1997 inspection of 100% of the SG tubes was done in an adequate manner (i.e., was a baseline for the review and inspection results did not need to be reviewed). He was not aware that the flaw in the row 2 U-bend (as noted in the 1997 inspection) was at the apex of the tube since this

was not specifically addressed in the SE. In fact, the location of the flaw in the U-bend was not in the licensee's December 1998 submittal nor in the May 1999 response to the RAI. This would have been a concern since a crack at the apex could break before there was leakage indication. However, the SG tube that failed would have still failed even without an amendment to extend the inspection interval had the plant operated (i.e., tube failure took place in less than the number of effective full power days that are allowed between SG inspections).

- 8) Was the licensee's submittal (original application and RAI response) considered complete and acceptable?

Original application was complete except for the information requested by the RAI. The application and the RAI response did not address the apex location of the flaw.

- 9) Do you have any views with respect to the findings in the RES review of the SE for this amendment?

He agrees that licensee's assessment of degradation found in the SGs was inadequate. He doesn't agree with the research statements with respect to crack growth rates. You can't really predict the size of a flaw at the end of an operating cycle. His assessment of the crack growth rates was that they were pretty well behaved from all appearances.

- 10) Do you have any suggested improvements with respect to the IP2 TSs?

The intent of the new regulatory framework is to relocate the details outside of the TSs. This will put more emphasis on the NRC inspection program. He thinks this is the correct approach rather than putting more requirements in the TSs. The outcome of the regulatory framework with NEI will need to be integrated into the revised oversight process. The regulatory framework will have performance criteria that should ensure SG tube integrity. If licensees just complied with the minimum inspection requirements per their TSs we would have more ruptures. We don't because the industry is doing more than is required by TSs. Also, the fact that we're experiencing less tube ruptures suggests that we're heading down the right road, i.e., that the mainstream are following the guidelines, but it is critical that oversight process catch outliers.

- 11) Do you believe that the licensee should have found the crack, considering the high level of noise in the U-bend area?

The data quality of the 1997 inspection was poor, however, the flaw that ruptured should have been caught in 1997. The licensee should have done a better job of digging the flaws out of the noise especially given the location at the apex of a row 2 U-bend. Since IP2 knew that they had significant copper problems, the testing techniques should have been modified to lessen the impact of the noisy signals. Unfortunately, industry guidelines say very little about data quality and digging flaws out of noise.

- 12) Do you know if the high frequency probe was commonly used by the industry in 1997? Will the NRC staff make a formal recommendation to the industry on the use of the probe?

Not sure the extent of use of high frequency probes. The industry has not yet made a recommendation to use them.

- 13) Jack Strosnider mentioned that the restart SE may contain a qualitative rather than a quantitative approach to the evaluation of the U-bend area - what does this mean?

Often there isn't enough information to know with certainty what the crack growth rates are (to put into the operational assessment). At that point, the staff needs to stand back and take a safety perspective - does the licensee have enough margin? This can be demonstrated by burst tests that show that the tubes with the most limiting flaws detected during the inspection can withstand up to three times the normal differential operating pressure without burst. This can also give the staff reasonable assurance that the tubes exhibit sufficient structural integrity until the next operating cycle, but showing that the tube with most limiting flaw that was left in service during the last cycle can still exhibit margin against burst. This type of argument is based on having a low enough detection threshold to demonstrate that margin exists, and is also dependent on growth rates behaving in a similar manner from one cycle to the next.

- 14) To what extent do other plants have significant noise problems?

Not sure how many have this problem. One plant, Kewaunee, does have similar noise problems. Kewaunee's problems are not as extreme, and they will be replacing generators soon.

- 15) Do you have any views on the Hopenfeld DPO?

Earlier resolution of the DPO would have had no impact on preventing the IP2 event.

#### Other Observations

Emmett also made the following observations:

- a) The phone calls we presently hold with the licensees to discuss SG inspection results does not fit any specific regulatory process. We still hold these phone calls during the outages with the licensees. They are not always tied to a license amendment. Some of these calls have resulted in further action by the licensee based on staff questions/concerns about the results. Furthermore, some of the calls are initiated by the licensees.
- b) Due to an agreement between NEI and the NRC in the context of NEI 97-06, in the future under the new regulatory framework we will only get reports from plants that had to plug more than a certain amount of tubes. This performance threshold does not necessarily correlate to which SGs may have tube ruptures in the near future.

- c) Emmett was stunned with the level of ignorance of the utility about denting, and the possible ramifications of having a U-bend flaw. If they had noted the flaw in the U-bend soon after Surry's tube rupture, they would have understood the importance of this finding. IP2 was only the 2<sup>nd</sup> tube rupture in a U.S. nuclear plant that should have been anticipated and avoided.
- d) IP2 had an earlier amendment related to denting/hour-glassing based on historical problems. There was a lot of attention to denting in the late '70s and early '80s based on the tube rupture at Surry. Most of the attention went away because a lot of the licensees chose to replace their generators with severely degraded tubes. The level of denting at IP-2 led to an inspection program reporting requirement in their TSs, but as time moved along, this became ad hoc and routine. Emmett assumed the licensee would be looking for hour-glassing based on their TSs. The licensee has no definition of what constitutes "significant" hour-glassing and no inspection technique was employed to detect it.
- e) The IP2 training program for eddy current testing is poor, and in fact, they have no formal training program at IP2. They use contractors and have very little inhouse expertise. The program oversight is provided by a Level III eddy current inspector that works for the licensee.
- f) The statement in the IP2 RAI response that a row 2 U-bend indication was first found after 23 years indicates that the growth rate is minimal is a ridiculous statement. Although the statement is ridiculous it really didn't affect the staff decision with respect to row 2 tube integrity because the reviewers believed that the results of the 1997 inspection established appropriate safety margins.
- g) NRC reviewers are under substantial pressures to complete their reviews on schedule but NRC management doesn't support the staff when an issue "turns south."
- h) Revision 6 to the EPRI guidelines will address the problems at IP2.
- i) The issues brought up in the RES memo must be addressed in the restart SE. RES will be given the restart SE for review before it is issued by NRR.
- j) The location of the U-bend crack is important information in determining the safety significance of the flaw. There has been a history of finding flaws at the U-bend tangent locations that exhibited leaking, and grew slowly enough to allow the plant to shut down to repair the tubes. Therefore, flaws found at the U-bend tangent would not have raised the safety concerns compared to finding flaws at the apex.