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March 30, 1998

Re: Indian Point Unit No. 2
Docket No. 50-247

Document Control Desk
US Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555-0001

SUBJECT: 10 CFR 50.54 (f) Response to NRC Generic Letter 97-06: "Degradation of Steam Generator Internals"

Pursuant to 10 CFR 50.54 (f), this letter and attachment constitute Consolidated Edison Company of New York, Inc.'s (Con Edison's) 90-day written response to the subject generic letter.

Generic Letter 97-06, "Degradation of Steam Generator Internals," dated December 30, 1997, requested that nuclear utilities submit information that will enable the NRC staff to verify whether the addressees' steam generator internals comply with and conform to the current licensing bases for their respective facilities.

Should you or your staff have any questions regarding this matter, please contact Mr. Charles W. Jackson, Manager, Nuclear Safety & Licensing.

Very truly yours,

Paul H. Kinkel

Attachment

Subscribed and sworn to
before me 30 day
of March 1998.

Gerald O. Cullen

GERALD O. CULLEN
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ATTACHMENT

Response to Generic Letter 97-06

Degradation of Steam Generator Internals

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
March 1998

Introduction:

Generic Letter 97-06 (GL), "Degradation of Steam Generator Internals" was issued to: (1) again alert addressees to the previously communicated findings of damage to steam generator internals, namely, tube support plates and tube bundle wrappers, at foreign PWR facilities; (2) alert addressees to recent findings of damage to steam generator tube support plates at a U.S. PWR facility; (3) emphasize to addressees the importance of performing comprehensive examinations of steam generator internals to ensure steam generator tube structural integrity is maintained in accordance with the requirements of Appendix B to 10 CFR Part 50; and (4) require all addressees to submit information that will enable the NRC staff to verify whether addressees' steam generator internals comply with and conform to the current licensing bases for their respective facilities.

This response provides information for Indian Point Unit 2 requested by the GL. The information requested includes:

(1) A discussion of any program in place to detect degradation of steam generator internals and descriptive inspection plans, including the inspection scope, frequency, methods and equipment. The GL requires discussions to include the following information for each facility:

   (a) Whether inspection records at the facility have been reviewed for indications of tube support plate signal anomalies from eddy current testing of the steam generator tubes that may be indicative of support plate damage or ligament cracking
   (b) Whether visual or video camera inspections on the secondary side of the steam generators have been performed at the facility to gain information on the condition of the steam generator internals (e.g., support plates, tube bundle wrappers, or other components).
   (c) Whether degradation of steam generator internals has been detected at the facility, and how the degradation was assessed and dispositioned.

(2) If the addressee currently has no program in place to detect degradation of steam generator internals, discussion and justification of the plans and schedule for establishing such a program, or why no program is needed.

Prior to issuance of the GL, the Westinghouse Owners Group, the Electric Power Research Institute and the Nuclear Energy Institute (NEI) developed an action plan to assess the susceptibility to secondary-side degradation. Indian Point Unit 2 intends to follow the industry action plan. Included in the action plan is a requirement to understand the causal factors involved in the degradation experienced in the French Units. This information is captured in EPRI report GC-109558, "Steam Generator Internals Degradation: Modes of Degradation Detected in EdF Units". This report was submitted to the NRC via NEI letter, dated December 19, 1997.

The Westinghouse Owners Group has reviewed EPRI GC-109558 relative to the design of Series 51 steam generators and determined limited potential susceptibility. The 51 Series designs are

the most similar to the EdF units. The Series 44 steam generators, such as the ones used at Indian Point Unit 2, have similar design features to the Series 51 steam generators.

Attachment 1 is a response to item 1 of the GL which has been completed for Indian Point Unit 2 addressing subsequent plant operation with potential steam generator internals degradation of the types experienced in the French Units (and other types of degradation experienced domestically). Item 2 of the GL does not apply.

A tentative inspection plan is discussed.

Attachment 1

Response to GL Item 1 for Series 44 Steam Generators at Indian Point Unit 2

Item 1

(1) A discussion of any program in place to detect degradation of steam generator internals and descriptive inspection plans, including the inspection scope, frequency, methods and equipment.

Background

Surveys were sent to all WOG utilities requesting the results of all steam generator, secondary side inspections and relevant tube inspections for tube support plate conditions. Completed surveys were received for 37 of 49 plants. For the 51 Series steam generators, responses were received for 18 plants. Of these, 16 responded as having inspected or reviewed inspection data for TSP ligament indications and 11 having performed SG secondary side entries that give confidence of not having wrapper drop. TSP ligament indications are reported for 468 ligaments in TSPs made of carbon steel with round tube holes and flow holes. The total number of tubes involved is on the order of 129,000 tubes with roughly 3.6 million ligaments.

The modes of degradation detected include many cases of flow-assisted corrosion, or erosion-corrosion, and of premature cracking that results from either surface fatigue or from corrosion cracking that is associated with surface conditions such as pitting or geometric concentrations. For the most part, however, the surveys do not report detection of several modes of degradation experienced in the EdF units. There is no evidence of post chemical cleaning inspections discovering any significant material losses. There is no evidence of any wrapper having dropped. There is no evidence of TSP ligament cracking or thinning that is progressive and continuing. TSP ligament cracking or missing pieces of ligaments have been observed, but only in units with carbon steel support plates with drilled round tube holes and flow holes. These conditions are generally traceable to initial inspections and are not progressing based on sequential inspection data. Many of the conditions are probably related to original TSP drilling alignment. There are cases of indications in TSPs that have been linked to patch plate welds.

Indian Point Unit 2 has significant hour-glassing of the tube support plates as a result of the denting process. Ligament cracking throughout the thickness of the support plate between the flow holes in the plate or the flow holes in the tube lane has been seen. If denting were to remain uncontrolled, as subsequent support plate corrosion occurs, the potential exists for fragments of the support plate material to become completely free of the main TSP structure. However, these plate segments generally remain locked in place because of the in-plane forces that give rise to denting, as well as the deformation that contains the individual piece. Ligament cracking was observed at Indian Point Unit 2 only in the lower support plates. Analyses done as part of the Westinghouse Denting Owners Group and recently for Indian Point Unit 2 concluded that 1) there are no safety consequences with regard to steam generator lower support plate deformation and ligament cracking, and 2) there are no tube vibration mechanisms which could cause excessive tube vibration and wear problems as a result of lower tube support plate ligament cracking. Denting is tracked by Con Edison which has long-

standing criteria and review by the NRC. In addition, the EdF experiences reported are not related to support plate degradation that has progressed to the tube denting stage.

Indian Point Unit 2 has Model 44 steam generators with carbon steel TSPs with significant denting and ligament cracking at the flow slots in the lower support plates. Cracking has not been seen in the upper two plates. The Model 44 steam generators have design features similar to the Model 51 Series steam generators.

The secondary side internal degradation types found in Westinghouse, 51 Series, and consequently 44 Series, steam generators with drilled carbon steel support plates are identified in Table 1.0.

Table 1.0
Susceptibility to Secondary Side Internals Degradation
in Westinghouse 51 and 44 Series SG Designs

Degradation Type	Level of Susceptibility
Erosion Corrosion:	
Moisture Separator	X
TSP Flow Hole/Ligaments	L
Feed Ring/J-Tubes	X
Cracking:	
TSP Ligaments Near Wedges(2)	N
TSP Ligaments Near Patch Plates	X(1)
Carbon Steel TSP Ligaments (Random Areas)	X(1)
Wrapper Near Supports(2)	N
Transition Cone Girth Weld	X
Other:	
Wrapper Drop(2)	N

X = Observed in some SGs
N = Not Susceptible to EdF Causal Factors
L = Low Susceptibility to EDF Causal Factors

(1) Various indications of degradation may be artifacts of manufacturing related to patch plate plug welds and/or drilling alignment.
(2) Various Westinghouse design features are beneficial relative to some of the steam generator design features of foreign manufacturers.

The Results of the Examinations Performed during the 1997 Indian Point Unit 2 Refueling Outage.

Upper support plates:

The uppermost support plate in Steam Generators 22 and 23 were visually examined, as was done during previous examinations. The examination used a videoscope inserted through the "hillside" port in the steam generator shell. No significant "hour-glassing" of the flow slots in the upper most support plate was observed. The wedge locations were also sampled in the examination, the wedges were intact. The condition of the tube surfaces appeared unchanged, flow holes were open and the support plates appeared sound.

Flow Slot and Lower Support Plate:

The video tapes of the lower support plate flow slots in Steam Generators 21, 22, 23 and 24, accessed by the lower handholes, showed essentially no change in "hour-glassing" of the flow slots in the lower support plates when compared to photographs taken during previous steam generator examinations. The current video and previous photographs also revealed cracks in the tube support plates at some flow slots. The current video quality was able to show small cracks at upper support plates, previously not observed. There was no significant change in the general flow slot cracking previously observed.

Wrapper:

A baseline measurement of the height of the wrapper above the tubesheet was taken for all four steam generators. The distances were consistent from steam generator to steam generator.

Secondary Side Examination:

A Foreign Object Search And Retrieval (FOSAR) was conducted in the steam generators around the annulus and within the tube bundle in February 1997. The FOSAR resulted in the removal of several items which previously could not be removed. The remaining items were evaluated for wear rates on adjacent tubes. The growth of eddy current indications from the previous outage were also reviewed and compared to determine if objects found on the secondary side of the steam generators contributed to localized external tube wear. The evaluation concluded that the Indian Point 2 steam generators could be returned to service with the identified items, and that operation during Cycle 14 with these foreign objects would not require a change to any Technical Specification, and did not represent an unreviewed safety question in accordance with 10CFR 50.59.

Safety Assessment

The following safety concerns have been postulated relative to the French steam generator internals, degradation experience. These are:

- Loss of support leading to wear and possible primary-to-secondary leakage or inadequate burst margins.
- More significant tube support plate deformation during a postulated LOCA +SSE event resulting in unacceptable steam generator tube collapse or secondary-to-primary in-leakage.
- The generation of a loose object in the secondary side of a steam generator which may result in tube wear or impacting and possibly primary-to-secondary leakage.

Based on a review of Table 1.0, the only degradation types that may occur domestically that may result in the loss of tube support plate integrity are: TSP flow hole/ligaments erosion-corrosion, TSP ligament cracking near the patch plates, and TSP ligament cracking in random areas. There are no observations of post chemical cleaning inspections discovering any significant material losses. There are no observations of any wrapper having dropped. There are no observations of TSP ligament cracking or thinning that is progressive and continuing. TSP ligament cracking or missing pieces of ligaments have been observed, but only in units with carbon steel TSPs with drilled round holes and flow holes. All utilities with 51 and 44 Series steam generators with carbon steel support plates inspect a significant percentage of steam generator tubes every outage with a bobbin probe, eddy current examination. If sections of the tube support plate are missing in non-dented units, this would be readily detectable due to a lack of eddy current response at the tube support plate elevation and actions can be taken to address the absence of the support. Future application of the voltage-based plugging criteria will also consider the presence of any missing ligaments. The alternate plugging criteria would not be applied at these locations.

There is no increased susceptibility to ligament cracking near the wedge supports in the 51 and 44 Series steam generator designs as either there are no flow holes extending to the periphery at the wedge locations or the wedges are not welded to the TSPs, as is the case with the EDF 51M steam generator. Existing calculations evaluating the effects of LOCA + SSE loadings on the tube bundle continue to apply in determining whether certain tubes should be removed from service in plants which may have steam generator tubes experiencing cracking at the tube support plate intersections.

Another occurrence resulting from steam generator internals degradation that may affect a steam generator from performing its intended safety function is the potential for tube wear and primary-to-secondary leakage due to the generation of a loose object on the secondary side of the steam generator. This may occur due to erosion-corrosion of the moisture separators, feed ring /J-tube, or tube support plate flow holes, or the occurrence of tube support plate ligament cracking. If primary-to-secondary leakage should occur due to tube wear from a loose object, the expected consequences would be bounded by a single tube rupture event and, therefore,

would remain within the current licensing bases of a plant. Regardless, it is the position of Con Edison that loose objects should be removed from the steam generator, whenever possible. In addition, tubes observed to have visible damage should be eddy current inspected and plugged if found to be defective. Eddy current inspection, foreign object search and retrieval (FOSAR) activities during each refueling outage and loose parts monitors should help to ensure the maintenance of tube integrity during subsequent plant operation.

For the types of steam generator internals degradation observed at Indian Point Unit 2, it is expected that steam generator internals degradation would be limited in extent such that the tubes will remain capable of sustaining the conditions of normal operation, including operational transients, design basis accidents, external events, and natural phenomena permitting the affected steam generator to perform its intended safety function.

Inservice Inspection Plan

Based on the above, the following inspection plan has been implemented at Indian Point Unit 2. Except where noted, these inspections will be completed each refueling outage. Inspection scope and frequency may be adjusted as necessary based on site specific experience and evaluation of industry results of these inspections.

Tube Support Plate Erosion-Corrosion and Cracking:

1. As the steam generator tube support plates in Indian Point Unit 2 are made of carbon steel, with severe denting and corrosion product buildup in the support plate crevices, with cracking of the lower support plates documented in the inspection results since 1977, the technique recommended to be employed as defined in the EPRI Report on the "Investigation of Applicability of Eddy Current to the Detection of Potentially Degraded Support Structures," dated May 1996, SG-96-05-003 cannot be applied. A periodic visual inspection of the upper support plate critical areas will be made on a sampling basis.

2. Inservice inspection will be conducted in accordance with Revision 5 of the EPRI PWR Steam Generator Examination Guidelines

   The critical area for mechanical or thermally induced support plate cracking is defined as 3 tubes around the periphery and 2 rows around the patch plate regions in each support plate. The critical area for ligament erosion/corrosion is the entire bundle. An initial sample of 20% of the tubes will be completed.

Wrapper Drop:

1. It will be verified that the sludge lance equipment can be inserted without interference. The frequency of sludge lancing at Indian Point Unit 2 is during every refueling outage.
2. If interference with the sludge lance equipment is detected, the lower wrapper support blocks will be visually inspected.
3. Since baseline measurements of the bottom of wrapper to tube sheet distance has been made, this dimension will be verified if wrapper drop is suspected in item 1.

Wrapper Cracking:

No inspection is recommended unless evidence of wrapper misposition or tube damage in the periphery of the first tube support plate is detected. If degradation is detected, a visual inspection of the lower wrapper support blocks will be conducted.

Upper Package:

Primary and Secondary moisture separators, feed ring (J-tube, carbon steel feed ring adjacent to J-tubes, T-section, reducer, backing ring and thermal sleeve)

1. There has been previous correspondence on these issues.
2. It is the practice at Indian Point 2 to perform a general visual examination entry in the secondary side of any steam generator opened. During the upcoming outage a sampling inspection is scheduled for J-tubes, feedrings and their plugs and the moisture separators.
3. The significant issue regarding tube integrity as a result of degradation of these components is primarily a loose part. Foreign object search and retrieval (FOSAR) is performed during every refueling outage.

Transition Cone Girth Weld:

Inspect in accordance with the steam generator shell, Section XI In-service Inspection requirements.

Feed Water Nozzle:

Degradation of the thermal sleeve may affect the feed water nozzle. Loose parts monitoring and in service inspection requirements for the feed water nozzle will be continued.

References

1. EPRI Report GC-109558, "Steam Generator Internals Degradation: Modes of Degradation Detected in EdF Units".
2. EPRI TR-107569-V1, "PWR Steam Generator Examination Guidelines," Revision 5.