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July 25, 1996

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Subject: Response to Request for Additional Information (RAI) Concerning Circumferential Cracking of Steam Generator Tubes (TAC No. M92244)
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

References (a) Letter from A. R. Johnson, NRC, to R. C. Mecredy, RGE, Subject: Request for Additional Information (RAI) Circumferential Cracking of Steam Generator Tubes (TAC No. M92244), dated December 19, 1995

(b) Letter from R. C. Mecredy, RGE to A. R. Johnson, NRC, Subject: Generic Letter (GL) 95-03 dated April 28, 1995 "Circumferential Cracking of Steam Generator Tubes" Response to NRC Request for Additional Information (RAI)

In Reference (a), the NRC requested that RG&E respond to seven questions which arose as a result of the staff review of our Generic Letter 95-03 response. In Reference (b), RG&E responded to questions 5 and 7 of the subject RAI based on the new Babcock & Wilcox International replacement steam generators which were installed during the 1996 refueling outage. The purpose of this letter is to respond to the remaining questions 1 through 4 and 6. The information provided in this response is based on the Westinghouse series 44 steam generators which were replaced during the 1996 refueling outage.

1 a) The former series 44 steam generators at Ginna station had a 2.25" mechanical roll into a 22" tubesheet. Indication of PWSCC in the inlet tubesheet expansion transitions was not detected until 1989. At this time the bobbin coil "turbo mix" was relied on as a flagging device for supplemental inspection utilizing the single coil pancake MRPC probe. Sleeve or plug repairs of 140 tubes in "A" S/G and 125 tubes in "B" S/G were performed. Examinations in 1990 and 1991 were performed using the same methodology, and resulted in sleeve or plug repairs of 37 tubes in "A" and 23 tubes in "B" S/G in 1990, and 59 tubes in "A" S/G and 19 in "B" S/G in 1991. All indications were axially oriented until 1991 when the first indications of circumferential cracking were detected at the inlet tubesheet

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expansion area. The two tubes with indications were bounded with a single coil pancake MRPC probe inspection and no other indications were found. The axially sensitive, cirumferentially sensitive, and pancake coil "3 coil" MRPC probe technology arrived in 1992, which was coupled with a more conservative examination approach of all open tubesheet expansions. The repairs for 1992 totalled 189 for expansion transition indications in "A" S/G, of which 6 had circumferential orientation, and 63 for expansion transitions indications in "B" S/G, of which 4 had circumferential orientation. 1993 examinations utilizing the "3 coil" probe on 100% of open tubesheet expansions resulted in 20 repairs from indications in expansion transitions in "A" S/G of which 15 had circumferential orientation, and 80 expansion transitions indications in "B" S/G, of which 2 had circumferential orientation. 1994 examinations utilizing the "3 coil" probe on 100% of open tubesheet expansions resulted in 120 repairs from indications in expansion transitions in "A" S/G of which 6 had circumferential orientation, and 66 expansion transitions indications in "B" S/G, of which 17 had circumferential orientation. 1995 examinations utilizing the "3 coil" probe on 100% of open tubesheet expansions resulted in 60 repairs from indications in expansion transitions in "A" S/G of which 17 had circumferential orientation, and 32 expansion transitions indications in "B" S/G, of which 9 had circumferential orientation.

RG&E had several expansion transition mockups fabricated with EDM notches and felt the "3 coil" technique had good detection capabilities. All of the above mentioned repairs occurred in the inlet tubesheet. Inspections were also performed in the outlet tubesheet expansion transitions for supplemental examination purposes and no outlet expansion transitions indications were detected.

1 b) The "short radius" U-bend area of the steam generator tubes has historically been difficult to provide quality data utilizing the bobbin coil. When an MRPC U-bend examination was performed, data was acquired from the #6 tube support inlet leg to the #6 tube support outlet leg. Starting in 1989, RG&E decided to utilize the single coil pancake U-bend MRPC probe in rows 1 and 2. Data was acquired in all open row 1 tubes. Row 2 data was also acquired for 65 tubes in the "A" S/G and 29 tubes in the "B" S/G. The data quality of the single coil pancake probe was a significant improvement over the bobbin coil method, and still no indications were detected. The philosophy for examinations in 1990, 1991, and 1992 was based on a random sample methodology. If a row 1 or 2 tube was included into the full length random sample, the U-bend area was further inspected with the single coil pancake probe. In 1990, 47 row 1 and row 2 tubes were examined in "A" S/G, and 30 row 1 and row 2 tubes were examined in "B" S/G. In 1991, 79 row 1 and row 2 tubes were examined in "A" S/G, and 71 row 1 and row 2 tubes were examined in "B" S/G. In 1992, 52 row 1 and row 2 tubes were examined in "A" S/G, and 61 row 1 and row 2 tubes were examined in "B" S/G. The U-bend examinations in 1993, 1994, and 1995 were approached with a more conservative philosophy, with all open row 1 and row 2 U-bends being examined. In 1993, U-bend examinations of 165 row 1 and 2 tubes in "A" S/G and

144 row 1 and 2 tubes in "B" S/G were performed. In 1994, U-bend examinations of 161 row 1 and 2 tubes in "A" S/G and 139 row 1 and 2 tubes in "B" S/G, and in 1995, 157 row 1 and 2 tubes in "A" S/G and 133 row 1 and 2 tubes in "B" S/G were performed. No U-bend PWSCC indications were detected throughout all of the inspections that were accomplished.

It should be noted that RG&E felt it was important to draw on industry experience to give an additional perspective on inspection philosophy. Eddy current data was obtained from plants with U-bend cracking to assure that eddy current analysts would recognize these U-bend indications. A mockup of various EDM notches were incorporated into a row 1 U-bend and dubbed the "Dream Standard". Eddy current data was acquired on this standard with the same equipment and cabling used during actual examinations at Ginna, and the results for detection of these notches were very good.

1 c) Ginna's steam generators contained secondary side corrosion product buildup in the annular region between the tube outside surface and the carbon steel support member. Minor distortions from this phenomena are present at many support areas, but denting has occurred primarily at; the tubesheet secondary face, within the tubesheet, at the #1 tube support plates, the #2 tube support plates, and the #6 tube support plates. Prior to performing MRPC of dented or undented intersections in 1991, RG&E acquired the services of a recognized industry leading Eddy Current analyst from Combustion Engineering who had considerable experience with the bobbin coil detection of cracking located within the tube support plate. The dented and undented support plate eddy current data was reviewed at a large number of intersections and no indications of cracking were detected. From 1991 through 1994, between 35 tubes and 45 tubes per steam generator were inspected at various support elevations. These tubes were tested with the "3 coil" technique. In 1991 and 1992 a sample of tubes were selected based on a dent voltage criteria of > 50 volts. The voltage was based on the bobbin coil measurements which were normalized at 8 volts on the 400 kHz differential channel (optimum frequency) off of the tube support ring. In later examinations a cross section of dented and undented intersections were examined. Dented regions within the tubesheet also had 100% examination during the 1992 full tubesheet MRPC examination. Indications of cracking were not detected in any dented or undented support examination.

1 d) Ginna has a long history of sleeving in the tubesheet area for crevice indications as well as expansion transition indications. Sleeves were first installed in 1980. The sleeve types include; B&W brazed, B&W explosive, B&W kinetic, and C-E welded, for a total sleeve population of 885 sleeves in "A" S/G and 1464 sleeves in "B" S/G. These sleeves are of various lengths, but basically all have an upper expansion area with a weldment or braze, with some sleeves having a lower expansion and weld or a lower seal weld at the tube end. The B&W bimetallic brazed sleeves and explosive sleeves had a preservice inspection with a magnetic biased bobbin coil and ultrasonic exam in the upper expansion area.

Subsequent exams included a magnetic biased bobbin coil or combination magnetic biased bobbin coil and crosswound bobbin coil probe. B&W Inconel 690 kinetic sleeves were baseline examined utilizing the rotating crosswound coil (MRPC), and later inspections with the plus point probe. The C-E welded sleeves were initially baseline examined with the crosswound probe and ultrasonic inspection was performed in the upper expansion area. Probe technology has improved, and baseline examinations as well as inservice examinations were performed with increased sensitivity with either the "I" coil, axial differential rotating coils, and more recently plus point rotating coils. During each outage a 20% sampling of each inservice sleeve type was performed, along with the baseline of all newly installed sleeves. Sleeves have been plug repaired during the years due to process induced defects such as inadequate braze or weld. Sleeves have also been repaired due to freespan sleeve indications and sleeve obstructions, no sleeve weld or brazed joint cracking has been detected.

2) Rows 1 and 2 have the shortest radius bends of any tubes in the steam generator and therefore are considered to be the most susceptible to PWSCC. It has therefore been RG&E's philosophy that these rows would be examined to identify any indications in "short radius" tubes. Response 1 b) provides the inspection information for these two rows.

3) This item is addressed in response 1 c).

4) RG&E has maintained the philosophy of repair of expansion transition indications based on detection of any indication throughout the life of the steam generators. As stated in our previous response we were not able to characterize the depth of circumferential or axial indications to make an assessment for satisfaction of Regulatory guide 1.121. Therefore, repairs of not only the largest, but all detected expansion transition indications were necessary, and no known expansion transition indications were left inservice. The inspections after 1992 had repeatability with the same probe type and it is felt that expansion transition indications were being detected early in their propagation. Due to the indications being detected early in their propagation, and all indications being repaired, the fact that no tube pull information or in-situ pressure tests were performed did not present a safety concern that would have prevented plant operation. The secondary side chemistry and radiation monitoring that was previously discussed was relative to plant operation and adherence to plant Technical Specifications. The worst case scenario of a tube rupture was analyzed for proof of the tube being restricted within the tube bundle which would limit the leak rate to less than the design basis tube rupture, due to the tube being restricted within the tubesheet and the leak path between the annulus of the tube outside diameter and the compacted crevice. The tube rupture scenario was not analyzed as a basis for leaving known expansion transition indications inservice, as all known indications were repaired.

6) As stated in response 1 a), RG&E began using the axially sensitive, circumferentially sensitive, and pancake coil "3 coil" MRPC probe in 1992. This technology is capable of detecting circumferentially oriented degradation in the roll transition. The inspection scope and results are described in response 1 a).

The information contained within provides the realization of RG&E's commitment to address all known tube high stress area's through Eddy Current inspections with the latest proven technologies. RG&E has maintained a conservative approach through augmented sampling of these area's throughout the life of Ginna's steam generators and in the case of expansion transitions through a comprehensive repair philosophy.

Very Truly Yours,

Robert C. Mecredy

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