UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO INSPECTIONS AND REPAIRS OF

INTERGRANULAR STRESS CORROSION CRACKING (IGSCC)

GEORGIA POWER COMPANY (GPC)

OGLETHORPE POWER CORPORATION

MUNICIPAL ELECTRIC AUTHORITY OF GEORGIA

CITY OF DALTON, GEORGIA

EDWIN I. HATCH NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-321

1.0 INTRODUCTION

The NRC staff has reviewed Georgia Power Company's (the licensee's) submittals dated April 30 and June 29, 1990, regarding the inspection results, flaw evaluations and overlay repairs to support the continued operation of Hatch Unit 1 in its present configuration for an 18-month fuel cycle. During the Spring 1990 Hatch Unit 1 refueling outage, 127 welds in the recirculation, residual heat removal (RHR) and reactor water clean-up (RWCU) piping systems were ultrasonically examined.

The results of the inspection showed that new flaw indications were found in seven 28-inch recirculation welds. In addition, new flaws and growth of existing flaws were reported in five unrepaired 28-inch recirculation welds. Standard weld overlays were applied to those 12 flawed welds.

2.0 DISCUSSION

Inspection

A total of 127 welds in the recirculation, RHR and RWCU piping systems were inspected during this refueling outage which included 34 previously overlay repaired welds, nine unrepaired welds and seven non-safety related RWCU welds outside the primary containment. The sampling for the non-safety related RWCU piping is about 10%. The original sample size required an inspection of 83 welds which was expanded to 127 welds after flaw-like indications were found in the original and expanded samples. The NRC staff concludes that the scope of the IGSCC inspection meets the staff requirements and the guidelines in Generic Letter 88-01. The staff also concludes that the limited sample expansion of Category C welds (welds mitigated by induction heating stress improvement (IHSI) process) is acceptable because all the welds with configuration similar to the welds found flawed during this outage were inspected and other Category C welds not inspected in this outage were inspected either in 1988 or 1987 outages.

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Ultrasonic Examination

The licensee indicated that during this outage ultrasonic examination was performed with both shear and refracted longitudinal wave techniques using a combination of manual and mechanized data recording. New flaw indications were found in seven 28-inch recirculation welds (28A-7, 28A-8, 28A-14, 28B-9, 28B-13, 28B-14 and 28B-15). These are Category C welds mitigated with IHSI. The worst cracking was reported in weld 18B-15, intermittently cracked in circumferential direction with a maximum through-wall depth of approximately 68%. Five 28-inch Category F welds (28A-2, 28A-4, 28A-6, 28B-6 and 28B-12) in the recirculation piping system were reported to have new flaws and growth of existing flaws. Category F welds are flawed welds with no weld overlay repair. All the 12 flawed welds mentioned above were weld overlay repaired during this outage. Examination of the remaining four Category F welds did not show significant changes in flaw sizes from previous examinations. The licensee reviewed the previous ultrasonic testing (UT) data of two Category C welds (28B-9 and 28B-15), which were found flawed during this outage. Weld 28B-9 was inspected in the 1988 outage and weld 28B-15 was last inspected in 1987. Heavy root geometry type signals were reported in the previous UT data. The licensee indicated that these signals could have been evaluated as IGSCC-like indications. As a result of this finding, the licensee reviewed the previous UT data of all Category C welds not inspected during this outage and did not find any suspicious indications that required further examination.

Flaw Evaluation

Flaw indications were found in some weld overlays. Most of these indications were characterized as lack of fusion between weld beads. One boat sample was taken from weld 28A-2. The result of the metallurgical examination of the boat sample has shown that the UT indications were actually porosity in the first layer of the weld overlay. Structural Integrity Associates, Inc. (SIA) performed the flaw evaluation for the licensee. All the flaws in the overlays were evaluated as acceptable in accordance with the requirements of ASME Code. The staff concludes that the flaw evaluations are acceptable.

Weld Overlay Repair

During this outage, 12 28-inch recirculation welds were overlay repaired with standard overlay design. SIA performed the overlay design for the licensee. The designed overlay thickness took the credit of the first layer of the weld overlay. One sided weld overlay was designed for six pipe or elbow to valve welds. The as-built thickness and length of each overlay repair were reported to meet the minimum designed dimensions. Prior to this outage, 34 welds were weld overlay repaired with 30 welds in the recirculation system and four welds in RHR system. SIA has evaluated the weld overlay induced shrinkage stresses in the recirculation piping systems. The largest shrinkage stress on unflawed welds was reported to be 13.26 ksi on a C riser weld 12BR-C-1. The shrinkage stresses at the three unrepaired recirculation riser welds varied from 1.97 ksi to 6.4 ksi. All weld overlay induced shrinkage stresses were reported to be within the ASME Code allowable. SIA reevaluated the flaws in three unrepaired welds using the revised shrinkage stresses and taking the credit of IHSI. The results of the reevaluation have shown that cracks in these unrepaired welds will not grow.

The NRC staff finds that SIA's overlay design took the credit of the first layer which contained ferrite content less than 7.5 FN. This is not consistent with the guidelines in Generic Letter 88-01, which require a minimum ferrite content of 7.5 FN to ensure adequate IGSCC resistance in the overlay. SIA reported that low ferrite content (6 to 7.5 FN) was measured in the first layer of some overlays deposited with heat #XT5941 of Type 308L stainless steel material. These layers were accepted in the overlay design because heat #XT5941 contained only 0.019 weight % carbon. SIA justified the acceptance of these low ferrite content layers by considering a trade-off benefit in IGSCC resistance between carbon and ferrite content, which was demonstrated in the studies performed by Electric Power Research Institute and General Electric Company. These studies have shown that the IGSCC resistance in austenitic stainless steel castings containing 0.02 weight % carbon and 5.5% ferrite is equivalent to the castings containing 0.035 weight % carbon and 7.5 FN. The staff does not agree completely with SIA's justification because SIA did not discuss the base metal dilution effect which has the potential of increasing the carbon content in the first layer of the overlay. The staff notes that the upper bound of the carbon content in the base metal such as type 304 stainless steel can be as high as 0.08%. If the carbon content in the base metal is high, the corresponding dilution effect will also be large. Because of the dilution effect concern as discussed above, the staff concludes that SIA's standard overlay design may not be conservative in accepting these initial layers with low ferrite content. The licensee should provide further justification based on the actual carbon content of the actual piping spool. If adequate justification cannot be provided, the licensee should reevaluate the effective thickness of each affected overlay and upgrade the affected overlay as necessary during the next refueling outage.

3.0 Conclusion

Based on our review of the licensee's submittals, the staff concludes that the licensee has adequately addressed IGSCC in stainless steel piping with respect to inspections and repairs performed during the Spring 1990 Hatch Unit 1 refueling outage, and that these activities were performed in accordance with the guidelines in Generic Letter 88-01, with the exception that those overlay repairs having low ferrite content in the first layer are not acceptable as standard design overlays. These affected overlays should be reevaluated based on actual carbon content. If adequate justification cannot be made to support the existing design, the overlays should be upgraded, as necessary, during the next refueling outage. In addition, the staff also concludes that Hatch Unit 1 can be safely operated for an 18-month fuel cycle in its present configuration.