UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION REGARDING THE REINSPECTION RESULTS OF THE CORE SHROUD VERTICAL WELDS

GEORGIA POWER COMPANY, ET AL.

EDWIN I. PLANT HATCH, UNIT 1

DOCKET NO. 50-321

1.0 INTRODUCTION

1.1 Purpose

The purpose of this safety evaluation is to assess the reinspection results and flaw evaluations submitted by Georgia Power Company, et al. (GPC or the licensee) for the Hatch Unit 1 core shroud vertical welds.

1.2 Background

The shroud was repaired at Hatch Unit 1 in the fall of 1994. The repair was intended to structurally replace the horizontal welds from H1 through H7. Therefore, these welds were not required to be inspected before the repair. However, because the repair did not structurally replace the vertical welds, they were required to be inspected. In view of the small cracks observed in the industry, the inspection performed in the fall of 1994 for the vertical welds at Hatch 1 was limited to visual inspection of 12 inches of the V3, V4, V5 and V6 welds near the intersection with the H4 weld. The actual length inspected for these welds was 18 inches. No indications were seen during this limited inspection and the unit was returned to service.

During the spring 1996 refueling outage, the vertical welds were examined again visually and more extensively in accordance with the recently issued BWRVIP guidelines on shroud reinspection (EPRI TR-105747, February 1996, "BWR Vessel and Internals Project - Guidelines for Reinspection of BWR Core Shrouds (BWRVIP-07)"). All accessible areas of all the vertical welds were inspected visually by enhanced VT-1 examination according to the BWRVIP inspection guidelines (EPRI TR-105696, October 1995, "BWR Vessel and Internals Project - Reactor Pressure Vessel and Internals Evaluation Guidelines (BWRVIP-03)") from the outside (OD). Welds V5 and V6 were examined both from the inside (ID) and the OD. Two indications, 2 inches and 12 inches in length, were seen in V5, and upon sample expansion in accordance with the guidelines, one indication 32 inches long and four small (1/2 inch) axial indications were observed in the V6 weld, both on the OD. Inspections on the ID showed no cracking for both the V5 and V6 welds. In its submittal, dated May 7, 1996, GPC evaluated the significance of these indications.

Enclosure

By letter dated June 27, 1996, the NRC staff requested the fracture mechanics analysis used by GPC for the above evaluation and a fracture mechanics analysis using a crack growth rate of 5 x 10(exp)-5 inches per hour instead of the 2.5 x 10(exp)-5 inches per hour that the licensee had used. GPC responded in a letter dated July 16, 1996.

2.0 DISCUSSION AND EVALUATION

Licensee's Submittal

GPC stated, among other things, that:

> The axial cracking in itself is not new; axial weld cracks have been seen in several plants, but the observed length at Hatch 1 in the V-6 weld seems to be somewhat larger. Most of the cracks in other plants have been around 3 in. with one case where it was about 15 in. So the 32 in. indication is longer than those seen elsewhere. Of greater interest is that at least a part of the region of the V-6 indication was visually inspected in 1994 and found to be uncracked. Unless indications were missed before, one has to conclude that the observed indication is new.
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> Hatch 1 has operated with excellent hydrogen water chemistry (HWC) during the last cycle, with calculated ECP [electro-chemical potential] levels below the -230 mV SHE [standard hydrogen electrode] threshold in the region of the H4 weld, the apparent 'new' initiation (if it is) is surprising. Review of the videotape by materials experts at GE [General Eletric] was inconclusive on the question of whether the indications represent actual shroud cracks. Some experts suggested that the indications may not be cracks at all and that they could be due to changes in the structure of the oxide film as a result of HWC. Similar indications were seen in the region of the access hole cover in another BWR operating under HWC. Subsequent UT [ultrasonic testing] showed no cracking. Others felt that shallow cracking existed during the prior outage, and the HWC induced changes in the oxide structure could have made the preexisting cracks visible. HWC also makes the surface topography more clear.
>
> The fact that there were no indications on the ID of the V-5 and V-6 welds is good, and suggests that the OD indication could have been due to other reasons such as cold work. There was general agreement that the indications did not have clear opening, and appeared to be tight suggesting that they are shallow.

GPC reviewed possible causes. It determined that vibration was not a credible cause. It reviewed the stresses due to the shroud repair and found them to be small and not high enough to cause cracking. It also decided that irradiation-assisted stress corrosion cracking (IASCC) was not a significant

factor since the indications were on the outside surface of the shroud where the fluence is lower than that at the inside surface and the extent of branching observed was not consistent with that for IASCC. The consensus of opinion of GE experts was that the change in oxide structure due to HWC was the most likely cause of seeing cracklike indications that might have been there during the last outage, and that even if the indications did represent cracking, they were tight and likely to be shallow.

GPC determined allowable crack lengths based on both linear elastic fracture mechanics (LEFM) and limit load analysis; LEFM was governing for welds V5 and V6. GPC determined the allowable through wall crack length to be 66.4 inches. The allowable crack length is less than the width of the shell course for V5 and V6 (98.8 inches). Alternatively, the required uncracked ligament is 32.4 inches. Under BWRVIP criteria for reinspection of shrouds, allowances are added for crack growth based on an assumed crack growth rate of 5 x 10 (exp)-5 inches/hr, for growth at both ends of the crack, and for inspection uncertainties. These allowances total 7.6 inches, a value that is added to the uncracked ligament length.

GPC stated in its justification for continued operation that:

> The allowable *through thickness* crack length for the V-5 and V-6 welds is 66.4 inches, including the safety factor. It [the analysis] also considers accident conditions and assumes that both H4 and H5 welds are fully cracked (360 degree through thickness cracking). If inspection uncertainty and crack growth for one cycle is considered, the allowable crack length is (66.4 - 7.6) = 58.8 in. This compares against the as found part through indication of 32 in. Alternatively, the required ligament is 40 in. compared to the available uncracked ligament of 98 - 8 - 32 = 66.4 in. Clearly, there is sufficient margin to justify continued operation beyond one cycle.

The licensee stated that (1) its analyses were conservative because its HWC would reduce the growth rate further, (2) that for the more realistic case of no through thickness crack at H4 and H5, the critical crack length for an axial crack length is expected to be longer than the weld itself, and (3) that it conservatively assumed through wall cracking and separate cylinders for each shell course.

Furthermore GPC concluded that:

> Thus continued operation for at least one cycle is justified. Additional inspections can be performed at the next outage to provide the basis for future inspections at that time.

Staff Evaluation

The staff determined that the licensee's inspections meet the BWRVIP criteria and the flaw evaluation is acceptable for the following reasons. The licensee's actions are in accordance with current industry practice and the BWRVIP's guidelines for reinspection of BWR core shrouds. The staff has

accepted the BWR Owners Group's commitments to follow these guidelines in the interim period until the NRC completes its review of them.

The fracture mechanics analyses were performed in accordance wi[illegible] ff-approved methods using staff-accepted growth rates. The analy[illegible] h applied the appropriate conservatisms, showed the cracks were [illegible] by a wide margin.

3.0 CONCLUSION

The staff finds that the core shroud flaw evaluations performed by GPC are acceptable and that continued operation for this cycle which ends in the fall of 1997 is justified. Additional inspections will be performed at the next outage which can provide the basis for assessing the growth of the indications.

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