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HARTSVILLE AND PHIPPS BEND NUCLEAR PLANTS - ALL UNITS

FAULTY WELDING BY LAKESIDE BRIDGE AND STEEL ON
DRYWELL VENT STRUCTURE AND REACTOR PRESSURE VESSEL PEDestal

10CFR50.55(e) REPORT NO. 2 (FINAL)

NCR'S HNP-A-037, HNP-A-050, EMP-3-024, AND PBNP-028

On June 6, 1979, TVA notified NRC-OIE Region II, Inspector W. B. Swan, of a potentially reportable 10CFR50.55(e) condition that has 10CFR Part 21 implications regarding a breakdown in the quality control program at Lakeside Bridge and Steel (Lakeside). The breakdown involves the shipment of the drywell vent structure and the reactor pressure vessel (RPV) pedestal by Lakeside with weld metal added to the edges (buttering) which has been found by TVA to contain material contamination causing cracking and enough porosity, lack of fusion, and slag inclusion deemed to be unacceptable per the American Welding Society (AWS), Code D1.1. An interim report on this deficiency was filed on July 5, 1979. This is the final report on the subject reportable deficiency.

Description of Deficiency

Drywell Vent Structure

As a result of the buttering problem identified on the reactor pressure vessel shield wall (NCR's HNP-A-037 and HNP-A-043), fabricated by Industrial Engineering Works (IEW), the TVA construction forces inspected the edges of the drywell vent structure fabricated by Lakeside for similar problems with buttering. The results of a spot check of some of the weld prep edges by radiography revealed that buttering had been performed, and that the buttering contained sufficient defects to be unacceptable by AWS standards. Subsequently, NCR HNP-A-038 was written to document this nonconforming condition.

None of the drywell vent structures for the Phipps Bend Nuclear Plant (PBNP) had been shipped from Lakeside; therefore, no NCR was written for PBNP.

Reactor Pressure Vessel Pedestal

During field erection of the reactor pressure vessel (RPV) pedestal fabricated by Lakeside, a routine weld inspection revealed cracks in an area outside of the zone of the TVA weld. These cracks have a horizontal orientation and appear to be from 1/8 inch to 3/8 inch below the circumferential weld which joins the ring girder to the shell section. Further visual inspection revealed similar cracks apparent at several other locations on the RPV pedestal. The results of preliminary liquid penetrant examination and acid etching indicate that the cracks developed along a line where the vendor apparently fused weld metal to the top edge of the parent metal (i.e., buttered the weld joint) to meet dimensional and/or edge geometry requirements. Some of the buttered edges which were radiographed by TVA contain sufficient amounts of porosity, lack of fusion, and slag inclusion to be deemed unacceptable under AWS Code D1.1.

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All segments of the RPV pedestal for PBNP unit 1 are onsite and none of the RPV pedestal for PBNP unit 2 is onsite.

Cause of the Deficiency

Drywell Vent Structure

The cause of the buttering deficiencies is due to unacceptable work which was not given sufficient NDE to result in its rejection and subsequent replacement. The existence of the buttering deficiencies can be attributed to a disagreement between Lakeside and the technical engineer (GE) over whether the procurement specification classifies buttering as a repair or not, and what NDE is required when buttering is performed. Both organizations agree that the buttering that was performed contains sufficient defects to be considered unacceptable per AWS Code D1.1.

Reactor Pressure Vessel Pedestal

Chemical and metallurgical examination of a specimen removed from a cracked area of the RPV pedestal revealed the cause of the cracking to be copper contamination in an area which was buttered to meet dimensional requirements. The origin of the copper is due to inadvertant melting of copper backup bars used in conjunction with the buttering procedure.

Safety Implications

Had the defects in the buttering performed by Lakeside, or the crack in the HTN A1 RPV pedestal gone undetected, the structural integrity of the RPV pedestal and drywell vent structure could be jeopardized under dynamic loading during an earthquake or LOCA.

Corrective Action

A. Repair of Defective Buttering

For all RPV pedestal and drywell vent structure segments shipped by Lakeside before June 1, 1979, TVA will perform the following in accordance with procedures that have been approved by the technical engineer (GE) during the field erection of the structures.

1. Locate all buttered edges by either visual inspection, acid etching, or radiography, or by using the Lakeside assembly records.
2. Perform 100-percent RT inspection on all buttered edges to locate all defects.
3. Remove unacceptable defects per approved procedure.
4. Perform MT or PT inspection to ensure sound metal where defects are removed.
5. Repair excavated area using a procedure approved by the technical engineer.
6. Perform 100-percent RT of the areas that are repaired. Steps 3 through 6 will be repeated until an acceptable quality buttering weld is attained.

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For all RPV pedestal and drywell vent structure segments shipped from Lakeside on or after June 1, 1979, Lakeside will perform 100-percent RT inspection and repair, as necessary, all buttered welds before the segments are shipped to TVA.

B. Cracks in the Hartsville Unit A1 RPV Pedestal

Steps as follow were used to repair the cracking in the RPV pedestal:

1. The entire circumference of both the inner and outer cylindrical all structures were cleaned and etched with nitric acid/water solution in the area where cracking was evident or suspected. Previous tests on a sample with known levels of copper contamination indicated that such an etching procedure would reveal the presence of copper by "darkening" of the weld beads into which copper had penetrated during welding.
2. Areas exhibiting the presence of copper from the etching, see Item B.1 above, were air-arc gouged to a depth of 3/4 inch and ground to bright metal.
3. These areas were then magnetic particle inspected to ensure sound metal where the copper contaminated areas were removed.
4. Excavated areas were repaired using the same procedure (SMAW process with AWS E7018 electrode) as used for the adjacent field weld.
5. Completed repairs were given 100-percent examination radiographically and by the magnetic particle method to assure an acceptable repair weld.

Means Taken to Prevent Recurrence

A. Repairs Made by Buttering

On May 2, 1979, GE sent letter No. GLB-61 to Lakeside stating GE's (i.e., the technical engineer's) interpretation of the requirements of the procurement specification with regard to buttering as follows:

1. Weld edge preparation with weld buildup material (buttering) shall require 100-percent radiography using acceptance standards of the applicable code.
2. If the supplier plans to use weld filler metal (buttering) in his fabrication process, a procedure should be submitted to the technical engineer for approval before buttering.

This action on GE's part should prevent any further misinterpretation by Lakeside of the procurement specification with regard to NDE and approval of buttering procedures. Also, the letters noted in part B should prevent future problems with buttering on this and other TVA nuclear plant structural steel contracts.

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B. Cracks in the Hartsville Unit A1 RPV Pedestal

On July 26, 1979, TVA sent letters to all companies holding contracts to provide structural steel for TVA nuclear plants describing the cracking problem at Hartsville Nuclear Plant and requesting that they refrain from using copper backup bars on their contracts with TVA. The letters further indicated requirements for TVA approval of weld repair procedures which should detail how the repairs will be made and subsequent nondestructive examination requirements for the repairs. These notifications should prevent recurrence of this problem in the future for TVA nuclear plants.