

ENCLOSURE

HARTSVILLE AND PHIPPS BEND NUCLEAR PLANTS - ALL UNITS  
UNACCEPTABLE BENDING OF WELDED STUD ANCHORS  
10CFR50.55(e) REPORT NO. 2 (FINAL)  
NCR'S HNP-A-064 AND PBNP-039

On August 30 and 31, 1979, TVA informed NRC-OIE Inspector W. B. Swan, of a potentially reportable condition under 10CFR50.55(e) regarding unacceptable bending of welded stud anchors (studs) on embedded plates at the Hartsville Nuclear Plant and the Phipps Bend Nuclear Plant, respectively.

This is the final report on this deficiency.

Description of Deficiency

Construction personnel were bending welded stud anchors (Nelson studs, etc.) to varying angles in order to clear interferences during the placement of embedments for concrete pours. No instructions from the design engineer on bending of these studs existed. Studs bent may have been designed to carry tension loads and the bending could possibly reduce the capability of embedments in tension to perform as intended by the designer (due to potential of reduced capacity of the studs).

At the time of identification of this problem (August 1979), Hartsville CONST was using a site guideline for STRIDE and BOP that the head of the bent stud had to be behind the rebar mat. On all STRIDE embedded plates, C. F. Braun had shown on their drawings oversized (longer and larger diameter than required by the design) studs. Using the guideline above with the STRIDE stud length and head size, the rebar mat location (3 inches into the wall), and rebar size, the maximum angle of bend would have been  $51^{\circ}$  (for the head to clear the rebar mat). Use of smaller studs (in BOP) would require a lower angle for the head to clear the rebar mat. Locations in STRIDE structures where a number of bends occurred were brought to the attention of the C. F. Braun site representative for his approval.

Phipps Bend had very few embedded plates installed in safety-related areas at the time this problem was identified. Those installed were floor plates in STRIDE and some floor, ceiling, or wall plates in nonsafety areas of the BOP (turbine building). A general guideline was being employed for STRIDE installations of a maximum allowable bend of approximately 30 degrees with the head of the stud being at least 6 inches into the wall after bending.

All stud bending at both sites was subject to the visual inspection and approval of site civil engineers and civil QC inspectors.

Cause of the Deficiency

The cause of the deficiency is the construction forces not following design drawings due to lack of specific instruction being provided by the design organizations to CONST on how to handle embedment interferences.

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### Safety Implications

Tests performed by TVA indicate no discernable loss of capacity due to the bending of welded stud anchors through angles as large as 45 degrees (largest angle used in the test). Since practices at Hartsville indicate that studs which were bent before identification of the condition were required to extend behind the rebar mat (giving a maximum angle of 51 degrees for the oversized studs used on STRIDE) and since the practice at Phipps Bend was to use lower angle bends than 45 degrees, TVA has determined that no degradation of the design capacity of the welded stud anchors at the Hartsville and Phipps Bend Nuclear Plants has occurred.

### Corrective Action

After this condition was identified in late August 1979, discussions were held within TVA and with GE/C. F. Braun. C. F. Braun indicated that 30° bends for studs on STRIDE embedded plates were acceptable without case-by-case approval in an August 31, 1979, letter to TVA. TVA (EN DES) issued a memo for Hartsville and Phipps Bend BOP allowing 15° bends on embedded plates (without requiring EN DES approval) on September 11, 1979, and C. F. Braun revised STRIDE instructions to agree with the TVA position on September 17, 1979. Interim instructions were issued by TVA (EN DES) in December 1979 to all TVA nuclear plant construction sites establishing limits (15° from the normal position) on the bending of studs on embedded plates. A testing program was also initiated to determine what effects bending of the studs had on their capacity. TVA has completed the testing program on the welded stud anchors and concluded that the bending of the studs up to 45° has no significant effect on the capacity of the studs. Based on the conclusion from the testing program, TVA (EN DES) issued new criteria in March 1980 to TVA CONST establishing the following conservative guidelines for maximum bending of welded stud anchors:

1. Structural steel plates used for supporting structural members to concrete - The bending of the studs from the normal position on the plate shall not exceed 30°.
2. Plates used as framing around doors, penetrations, edge of slabs, curb angles, hatch openings, and any edge protection application - Fifty percent of the studs may be bent up to 45°.
3. Heavy-duty inserts - Fifty percent of the welded studs may be bent up to 45° provided:
  - (a) No more than three adjacent studs are bent.
  - (b) The number of straight studs on the plate shall equal or exceed the number of bent studs in succession.

TVA (EN DES) has investigated other TVA nuclear plants with respect to bending of studs during construction and has not uncovered any problems concerning bending of studs.

Action to Prevent Recurrence

Implementation of the criteria discussed above (see Corrective Action) should prevent recurrence of this condition at all TVA nuclear plants.