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MAR 2 2 1984

Dr. Thomas E. Murley
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

SUSQUEHANNA STEAM ELECTRIC STATION
SECOND INTERIM REPORT ON A DEFICIENCY INVOLVING
BASE METAL CRACKING IN ANGLE FITTINGS
ER 100508 FILE 821-10
PLA-2140 Docket No. 50-388

Reference: (1) PLA-2120 dated March 7, 1984 (first interim report)

Dear Dr. Murley:

This letter serves to provide the Commission with a second interim report on a deficiency involving cracking in the base metal of angle fittings used on Class 1E electrical raceways and Category 1 HVAC supports. This deficiency was reported under 10CFR50.55(e) as potentially reportable by telephone to Mr. G. Kelly of NRC Region I by Mr. R. M. Harris of PP&L on February 6, 1984.

The attachment to this letter contains a description of the problem, its cause, the safety implications, and the corrective action.

Since the details of this report provide information relevant to the reporting requirements of 10CFR21 for Unit 2, this correspondence is considered to also discharge any formal responsibility PP&L may have for reporting in compliance thereto.

We expect to provide a final report on this deficiency in June, 1984. We trust the Commission will find this report to be satisfactory.

Very truly yours,

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

Attachment

A E27

Copy to:
Mr. Richard C. DeYoung (15)
Director-Office of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. G. McDonald, Director
Office of Management Information & Program Control
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. R. H. Jacobs
U.S. Nuclear Regulatory Commission
P.O. Box 52
Shickshinny, PA 18655

Records Center
Institute of Nuclear Power Operations
1100 Circle 75 Parkway, Suite 1500
Atlanta, GA 30339

SUBJECT

Base metal cracking of angle fittings used for seismic class 1E raceway supports and seismic category 1 HVAC duct supports located throughout Susquehanna Steam Electric Station, Units 1 and 2. The fittings were supplied by Unistrut, Powerstrut, B-Line and others.

DESCRIPTION

As indicated in Reference (1), Bechtel Power Corporation informed PP&L of a base metal cracking problem with the above mentioned fittings used on other Bechtel projects. The fittings of concern are 1-5/8 inch wide by 1/4 inch thick with legs ranging from 2-1/2 to 5 inches. The angle between the legs is less than 90 degrees. The cracking occurs at the inside of the bend.

PP&L initiated an extensive inspection and testing program to ascertain the extent of the cracking deficiency and the impact of the deficiency on the load carrying capability of the fittings. During the testing another area requiring investigation arose. The acute angle fittings reached their ultimate capacity by bending (or a combination of bending and cracking) near the bolt at loads lower than assumed during the initial design of the connections.

Therefore the testing program was revised to address both the cracking at the inside of the bend and the bending near the bolt.

In addition a complete drawing review (supplemented by field walkdowns) was initiated to determine the loading on the angle fittings of raceway and duct supports. The actual fitting loads were then compared to the test results.

CAUSE

The cracking and bending deficiencies each have their own cause as described below:

(1) Cracking Deficiency

During fabrication, ASTM A575 flat plate is cold bent to an acute (less than 90 degrees) angle. Although ASTM A575 allows for cold bending, a moderate bend radius is required. The fittings are bent to a sharp radius and in fact the bend may have no radius at all. Therefore, the fittings are subjected to severe cold working causing the material to become strain age embrittled. If, during installation the angle fittings are subjected to reverse bending by forcing the angle legs apart, the angle bending may crack on the inside radius.

(2) Bending Deficiency

The connections were designed assuming that the angle fittings were not the critical part of the connection. Both the bolts and welds of the fittings can accommodate a minimum normal load of 1500 lbs. and a faulted load of 2250 lbs. Testing results indicate that the ultimate load carrying capacity of the angle fitting to be somewhat less than that of the bolts and welds. Therefore, an inconsistency exists between the connection design strength arrived at analytically and the fitting strength determined through testing.

TECHNICAL EVALUATION

(1) Field Inspections

150 samples (75 from each Unit) were visually inspected. 58 out of 150 (39%) were judged to contain cracks or linear indications.

(2) Testing

(a) Acute Angle Fitting Static Test

Half of those judged to be deficient were tested statically. See Figure 1 for the test fixture and angle fitting orientation. Being that the legs of the fitting are of different lengths, two connection orientations were possible. Therefore both orientations were tested. The following results were obtained:

Orientation	Minimum Ultimate Strength (lbs)	Minimum Load at 1/4" Deflection (lbs)	Average Ultimate Strength (lbs)	Average Strength at 1/4" Deflection (lbs)
Long Leg Vertical	1060	1060	1750	1670
Short Leg Vertical	860*	820*	1235	1213
Combined Results	860*	820*	1484	1433

(*This number excludes one test anomaly)

(b) Acute Angle Fitting Fatigue Test

One quarter of the cracked, acute angle fittings were fatigue tested (oriented with the long leg oriented vertical) to $\pm$1000 lbs. for 60 cycles at 5 seconds per cycle. All fittings remained intact throughout the test. See Figure 1 for the test fixture and angle fitting orientation.

(c) Obtuse Angle Fitting Static Test

Due to the fact that a connection usually consists of one obtuse angle fitting and one acute angle fitting, the obtuse angle fittings were checked for their capacity (See Figure 2 for the test fixture and angle fitting orientation). The legs of this fitting are of different lengths so both orientations were tested. The following results were obtained using new obtuse angle fittings:

Orientation	Minimum Ultimate Strength (lbs)	Minimum Load at 1/4" Deflection (lbs)
Long Leg Vertical	5880	3500
Short Leg Vertical	2460	1633

(d) Combined Fitting Static Test

Due to the wide disparity in results between the acute and obtuse angle fitting tests, it was felt that the results could not be adequately combined to determine the capacity of the combined connection using an acute and obtuse fitting attached to the same member. Since the vast majority of the connections used in the construction of the plant used combined angle fittings it was felt necessary to perform a combined test to simulate the actual condition. The test was performed for both orientations using new fittings (See Figure 3 for the test fixture and the angle fitting orientation). The following results were obtained:

Orientation	Minimum Ultimate Strength (lbs)	Minimum Load at 1/4" Deflection (lbs)
Long Leg Vertical	4850	3320
Short Leg Vertical	3700	2630

(3) Drawing Review and Field Walkdowns

The following drawings were reviewed for support type, location, loading, and brace direction:

(a) All as-built duct support drawings
(b) All generic duct support drawings
(c) All generic raceway support drawings
(d) Specific as-built cable tray support drawings (for highly loaded supports, or high acceleration areas).

Field walkdowns of specific highly loaded supports and high acceleration areas supplemented the drawing review information.

(4) Engineering Analysis of Field Information

The maximum load per angle fitting connection was calculated for each support type considering; tributary dead load, location faulted accelerations, brace direction, and angle and number of fittings.

CONCLUSIONS

The following was concluded from the test results.

(1) No sample failed (separated in two) due to cracking at the bend of the angle fitting.

(2) The ultimate capacity of the angle fittings is limited by bending near the bolt.

(3) The acute angle fitting can be considered to have a faulted load capacity of 800 lbs.

(4) The combined angle fitting connection (which represents the configuration in the majority of the angle fitting locations in the plant) can be considered to have a faulted load capacity of 2000 lbs if the short legs are attached to the brace and 2500 if the long legs are attached to the brace.

(5) The faulted load on each fitting was compared to the test results. No fitting was found loaded beyond its capacity.

(6) Although the test program is not complete, there is sufficient data to conclude that the balance of testing will not deviate substantially from the results obtained to date.

For the following reasons, PP&L now is confident that both deficiencies will ultimately be dispositioned as not reportable under the provisions of 10CFR50.55(e) and that the seismic Category I duct and the seismic Class IE raceway supports using these fittings are capable of supporting the loads presently imposed upon them during normal as well as faulted conditions:

(1) Cracking of the angle fittings has been shown by testing not to be the mode of failure. The phenomenon primarily responsible for the reduced fitting capacity as determined by the test results is that of bending.

(2) The actual fitting loads (as determined from the drawing reviews and walkdowns) are lower than the allowable loads arrived at from the test program.

CORRECTIVE ACTIONS

The following additional actions have or will be taken to insure that all safety concerns are adequately addressed:

(1) The angle fittings have been added to PP&L's "Defective Device List." This list ensures that defective devices are not introduced into Susquehanna via modifications or the procurement/use of spare parts.

(2) The PP&L conduit installation specification (C1035) will be revised to restrict the use of new angle fittings and to restrict the addition of new loads to existing supports using angle fittings.

(3) The generic conduit and junction box support drawings will be revised to reflect the testing results.

The results of all testing and the completed engineering evaluation will be documented in a final report currently scheduled for a June 1984 submittal.

FIGURE 1

ACUTE ANGLE FITTING TEST ORIENTATION

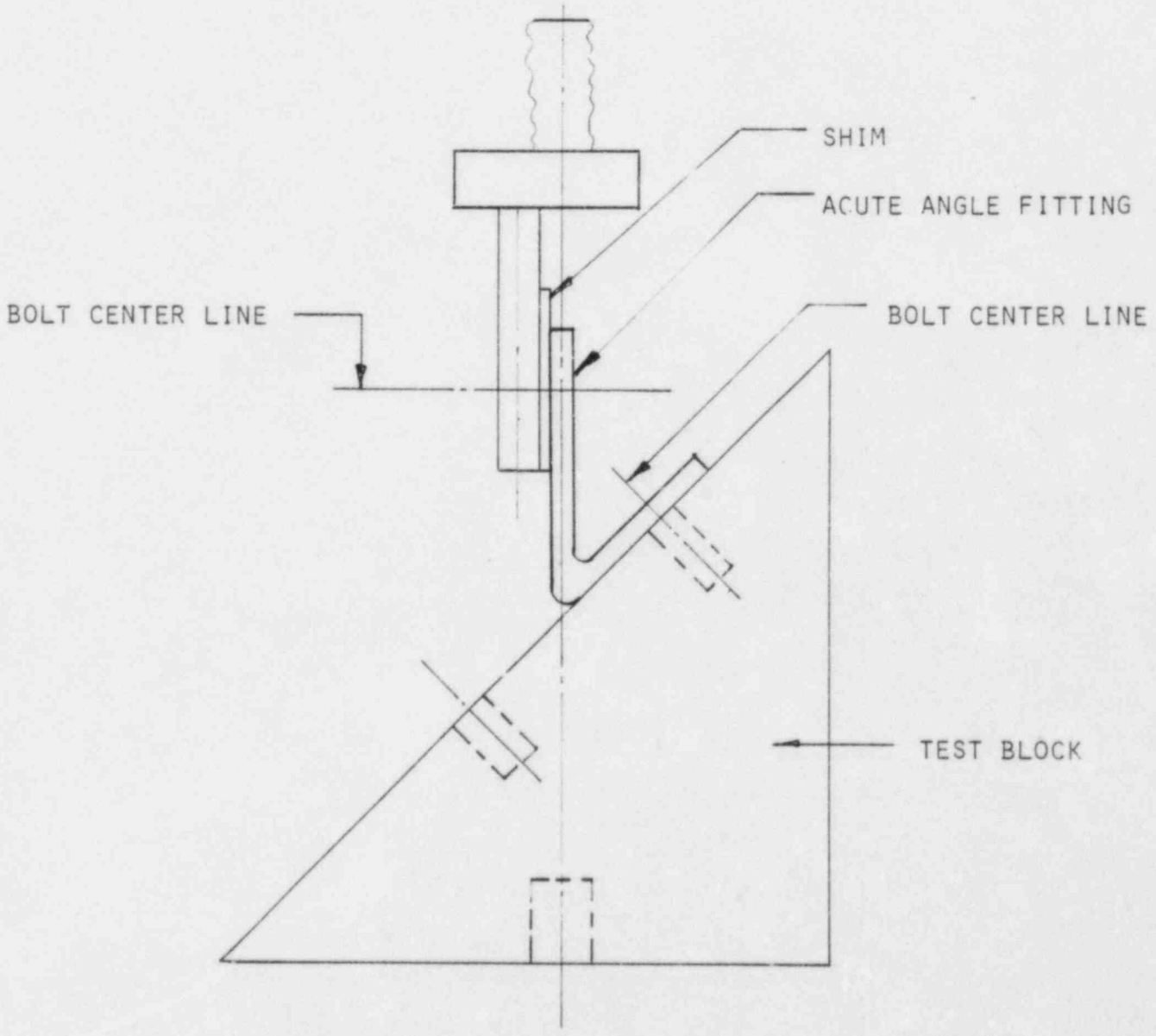

FIGURE 2

OBTUSE ANGLE FITTING ORIENTATION

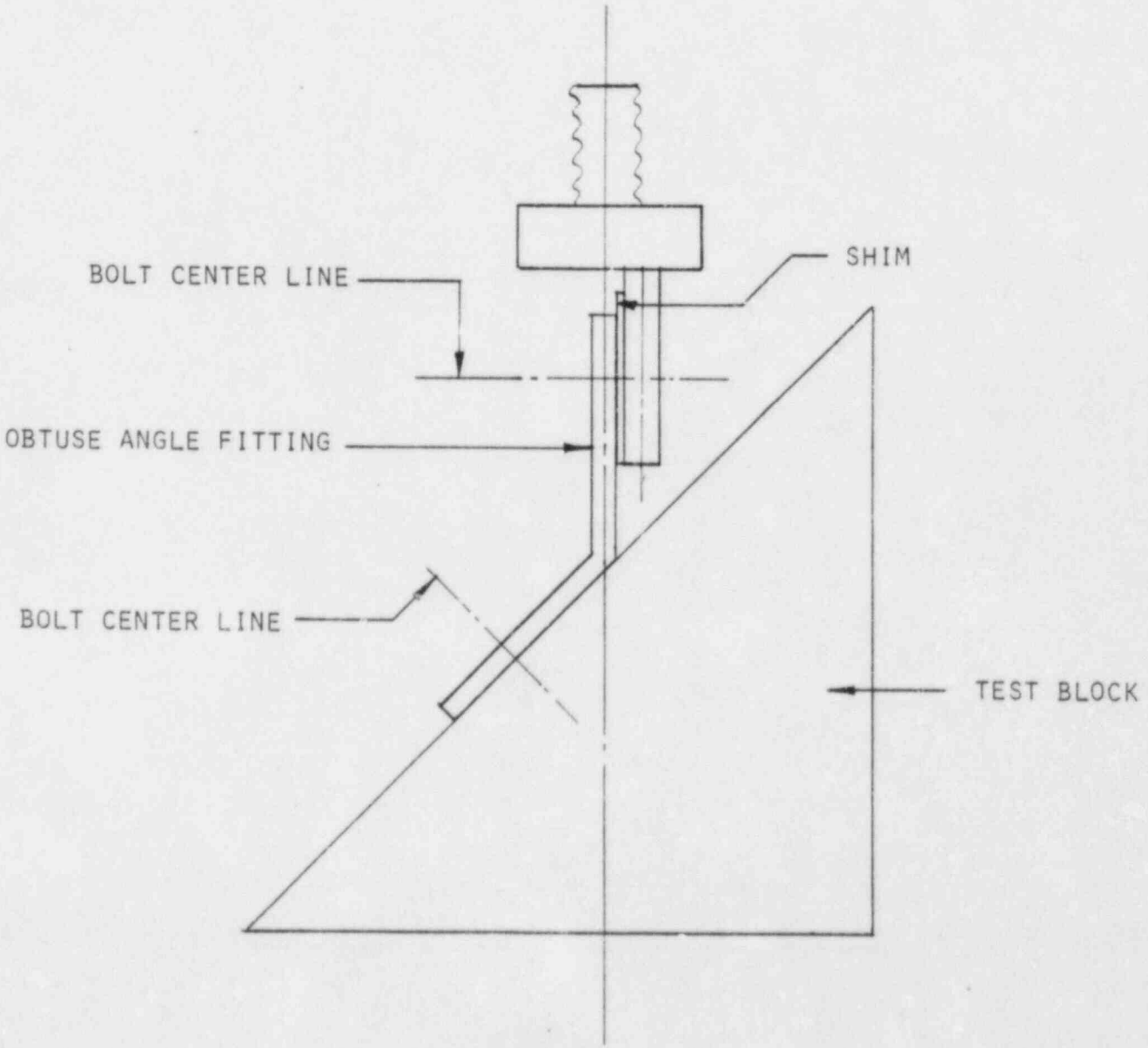

FIGURE 3

COMBINED F. TING TEST