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ENERGY SERVICES
101 California Street, Suite 1000, San Francisco, CA 94111-5894 415 397-5600

January 31, 1985
84056.053

Mr. J. B. George
Project General Manager
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Highway FM 201
Glen Rose, Texas 76043

Subject: Phase 4 Open Items - Punching Shear
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 4
Job No. 84056

Reference: N. H. Williams (Cygna) letter to J. B. George (TUGCO), "Phase 4 Open Items - Punching Shear," 84056.051, January 29, 1985.

Dear Mr. George:

The attachment to the above referenced letter has been revised to correct the following three areas:

1. The attachment refers to pipe support drawing MS-1-002-005-S72R. A copy of this drawing was inadvertently omitted when the letter was distributed. Cygna has revised Attachment A to eliminate the statement: "(see attached support drawing)." The drawing was provided as an example only and is not integral to the point being made.

2. In the last sentence of comment one, change "all" to "an" (typographic error).

3. In the first sentence of comment two, Cygna has deleted "a yield line analysis of the finite element results" and inserted the words shown, which better describe Cygna's approach to the evaluation.

This letter and attachment therefore supersede letter 84056.051 and its attachment. Please call if you have any questions.

Very truly yours,

N. H. Williams

N. H. Williams
Project Manager

NHW/ajb

Enclosure

cc: Mr. V. Noonan
Mr. S. Burwell
Mr. S. Treby
Mr. D. Wade
Mrs. J. Ellis

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ATTACHMENT
(Revision 1)

Calculation of Allowable Punching Shear/Joint Capacity in Tubesteel with Holes

For support MS-1-002-005-S72R, Cygna performed a finite element analysis to determine the effects of tube warping, and check the stresses in the tubesteel and coverplate in the region of the U-bolt hole. On October 4, 1984, Cygna requested that TUGCO review this support and provide calculations justifying the design. TUGCO submitted calculations on October 18, 1984, which showed that stresses in the tubesteel were acceptable using the "punching shear" method of AWS D1.1-79, Section 10.5.1. Cygna further requested justification for use of "punching shear" as an appropriate check. TUGCO provided their justification in their letter dated November 8, 1984 (L. Popplewell, TUGCO to N. Williams, Cygna).

Cygna has reviewed the TUGCO justification and has the following comments:

A. The AWS equation for calculating the punching shear allowable for tubesteel connections is based upon the results of a limit analysis assuming a specific yield-line pattern within the chord of the tubesteel. When a hole is placed in the tubesteel and the edge of the hole is loaded, limit analysis would predict a different yield-line pattern. This new yield-line pattern will result in a lower allowable punching shear. The presence of the coverplate further complicates the problem of determining punching shear allowables since one cannot automatically expect an increase in the AWS punching shear allowable proportional to the increase in thickness provided by the addition of a coverplate. In addition, the close proximity of the load to the edge of the tubesteel also influences the calculation of an allowable punching shear.

B. In the actual problem modeled and reviewed by Cygna, our finite element analysis predicted very little margin to allowable in the coverplate using an average of the finite element results along a line between the hole and the edge of the coverplate. The TUGCO calculation received on October 18, 1984, clearly shows a margin of approximately 6:1 (12.76/2.21). Thus, the TUGCO calculations would predict that this joint is acceptable for approximately six times more load, a fact not borne out by the finite element analysis. While Cygna did not consider plate plasticity effects in the finite element analysis, Cygna is, nevertheless, concerned with the

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large difference in predicted capability, and attributes much of it to the use of AWS D1.1-79 without assessing the impact of the deviations from D1.1-79. That is, one must consider that:

1. D1.1-79 assumes the brace and chord are welded together. Thus, the brace locally stiffens the chord. This is not the case for the nut loading the tubesteel.

2. D1.1-79 assumes the chord is solid. This is not the case for tubesteel with a hole in it.

3. D1.1-79 states that yield-line analysis can be used if $\beta < 0.8$, which is true for this joint ($\beta \equiv .6$). Thus, AWS does recognize that yield line theory can also be used to predict joint strength in configurations pictured in AWS.

Based on the above, Cygna does not accept the use of AWS D1.1-79 as an appropriate method for establishing an allowable punching shear/joint capacity in the case of tubesteel with loaded holes (with or without coverplates). Cygna requests that TUGCO provide further justification on the design of such unique joints.