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January 29, 1985
84056.051

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 L. M. Popplewell (TUGCO), "Open Items Associated with Walsh/Doyle Allegations," 84042.22, January 18, 1985

Dear Mr. George:

Cygna and TUGCO have corresponded on several occasions regarding the punching shear/joint capacity of tubesteel with holes. The attachment to this letter summarizes Cygna's differences with TUGCO on the acceptability of using an AWS D1.1-79 methodology for checking the adequacy of these designs. Cygna does not consider this to be a standard design -- particularly when punched tubesteel is used as the backing plate for a cinched U-bolt. We believe that careful consideration should be given to applying AWS without considering the basis for the standard.

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Per S. Burwell 2222 See Attached
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This letter completes Cygna's commitment listed under item 4 of the Open Items List attached to the above referenced letter. Please call at your convenience if further discussion of this position is necessary.

Very truly yours,

N. H. Williams
Project Manager

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

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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 (see attached support drawing). 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:

1. 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 all allowable punching shear.

2. In the actual problem modeled and reviewed by Cygna, our finite element analysis predicted very little margin to allowable in the coverplate using a yield-line analysis of the finite element results. 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 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:

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a. 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.

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

c. D1.1-79 states that yield-line analysis can be used if $\beta < 0.8$, which is true for this joint ($\beta \cong .6$). 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.