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

January 29, 1985
84056.052

P. B. Bloch, Esq.
Chairman, Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
4350 East West Highway, 4th Floor
Washington, D. C. 20814

Dr. W. H. Jordan
881 W. Outer Drive
Oak Ridge, Tennessee 37830

Dr. K. A. McCollom
Dean, Division of Engineering, Architecture and Technology
Oaklahoma State University
Stillwater, Oklahoma 74074

Gentlemen:

Enclosed for your information is a copy of Cygna letter 84056.050 summarizing the status of Cygna's overall conclusions for all four phases of the Independent Assessment Program. This letter was transmitted to the NRC Staff last week.

Very truly yours,

N H Williams

N. H. Williams
Project Manager

Enclosure

cc: See Attachment

Mrs. Juanita Ellis
President, CASE
1426 S. Polk
Dallas, Texas 75224, w/o attachment

Nicholas S. Reynolds, Esq.
Bishop, Liberman, Cook, Purcell & Reynolds
1200 Seventeenth Street, N.W.
Washington, D.C. 20036, w/o attachment

Robert Wooldridge, Esq.
Worsham, Forsythe & Sampels
2001 Bryan Tower
Dallas, Texas 75201, w/attachment

Mr. H. R. Rock
Gibbs & Hill, Inc.
393 Seventh Avenue
New York, New York 10001, w/attachment

Mr. A. T. Parker
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, Pennsylvania 15230, w/attachment

Renea Hicks, Esq.
Assistant Attorney General
Environmental Protection Division
P.O. Box 12548, Capitol Station
Austin, Texas 78711, w/attachment

Mr. James E. Cummins
Resident Inspector/Comanche Peak Steam Electric Station
c/o U.S. Nuclear Regulatory Commission
P.O. Box 38
Glen Rose, Texas 76043, w/attachment

Mr. S. Burwell
Licensing Project Manager
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20014, w/o attachment

Mr. John T. Collins
U.S. NRC, Region IV
611 Ryan Plaza Drive
Suite 1000
Arlington, Texas 76011, w/attachment

Mr. Lanny Alan Sinkin
114 W. 7th, Suite 220
Austin, Texas 78701, w/attachment

Mr. B. R. Clements
Vice President Nuclear
Texas Utilities Generating Company
Skyway Tower
400 North Olive Street
L.B. 81
Dallas, Texas 75201, w/attachment

Stuart A. Treby, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
7735 Old Georgetown Road
Bethesda, Maryland 20814, w/o attachment

Mr. J. B. George
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Highway FM 201
Glen Rose, Texas 76043, w/o attachment

Mr. David H. Wade
Texas Utilities Generating Company
400 North Olive Street, L.B. 81
Dallas, Texas 75201, w/o attachment

Mr. David R. Pigott
Orrick, Herrington, & Sutcliffe
600 Montgomery Street
San Francisco, California 94111, w/o attachment

Ms. Ellen C. Ginsburg
Atomic Safety and Licensing Board
4350 East West Highway
Bethesda, Maryland 20814, w/attachment

Mr. V. Noonan
U. S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20814, w/o attachment

CYGNA
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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Mr. J. B. George
January 31, 1985

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

ATTACHMENT
(Revision 1)

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.

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

January 31, 1985
84042.025

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 3 - Walsh Doyle Allegations
Richmond Insert Allowables and Bending Stresses
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Independent Assessment Program
Job No. 84042

Reference: N. H. Williams (Cygna) letter to V. Noonan (USNRC), "Open Items Associated with Walsh/Doyle Allegations," 84042.022, dated January 18, 1985.

Dear Mr. George:

Cygna has additional concerns with TUGCO's method of developing Richmond insert allowables and evaluating bending stresses when used in combination with tube steel. These concerns are listed in the attachment to this letter.

This letter completes Cygna's commitment listed under item 12 of the Open Items List attached to the above referenced letter. If you have any questions or wish to discuss the subject, please call.

Very truly yours,

N. H. Williams

N. H. Williams
Project Manager

NHW/ajb

Attachment

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

ATTACHMENT

Richmond Insert

Reference: (1) Affidavit of John C. Finneran, Jr., Robert C. Iotti, and R. Peter Deubler Regarding Design of Richmond Inserts and Their Application to Support Design.

(2) Calculations attached to the TUGCO letter to Cygna dated May 8, 1984.

Cygna has performed a review of the above referenced TUGCO Affidavit and May 8, 1984 calculations. The Affidavit included test results and calculations provided as justification for the Richmond insert allowables and a detailed analysis of the tubesteel connection designs. As a result of the testing and calculations performed by TUGCO, Cygna has drawn the following conclusions:

1. TUGCO performed testing to justify the single insert allowables published in specification 2323-SS-30. While Cygna is in basic agreement with the testing procedures and results, Cygna has two questions related to the tests:

   - Cygna has seen a minimum concrete compressive strength of 4000 psi throughout our reviews of calculations for pipe supports and cable tray supports. Cygna requests documentation which shows that the actual concrete compressive strength in all buildings with Richmond inserts exceeds the 4900 psi concrete used in the tests (Affidavit, page 14).
   - Cygna has not found sufficient justification for the safety factor of 1.8 for emergency/faulted conditions. Cygna is, however, pursuing this question as part of our Phase 4 cable tray reviews and notes it here only for information.

2. TUGCO performed a series of tests to justify their method of calculating the axial force in a bolt/insert due to torsion of tubesteel. TUGCO's evaluation of the test results concludes that a safety factor on the order of 3.2 to 4.0 is justifiable. Cygna, however, has the following questions and comments:

   - The tests of tubesteel/bolt combinations do not include the larger sizes of tubesteel, for example support MS-1-002-006-C72K (8x8x 1/2") or CT-1-039-413-C42A (10x6x 1/2"). TUGCO should justify that similar safety factors are expected for the larger sizes.
   - Only one test was run on each tubesteel/bolt combination. TUGCO should justify that the results are repeatable.

ATTACHMENT
(continued)

- TUGCO should clarify the location above the concrete surface of the applied load in the shear and torsion tests. The Affidavit (page 29) indicates it is two inches above the top of the tubesteel for the torsion test. This appears to be physically impossible since the distance from the top of the tubesteel to item four (Attachment F-4) is 2.75 inches.
- The moment listed in Table 1 (Part B) is referred to in the Affidavit as torsion. Please clarify the axis about which this is taken.
- What concrete compressive strength was used in the Richmond insert/tubesteel tests?
- Referring to the torsion test on the 4x4x 3/8 tubesteel with 3/4" offset, the Affidavit states (page 29): "When the shear equals 3 kips, the corresponding torsion is 21 in-kips." This implies a moment arm of 7" about the tube longitudinal axis. If the applied load is only 2" above the top of the tubesteel, the moment arm to the tube longitudinal axis is only 4", and the torsion is 12 in-kips. While Cygna realizes that there is a logical alternative, i.e., that the torsion refers to a moment at the concrete surface, there must be correlation between the value of torsion in the test and that reported in Table 1 (Part B) of the Affidavit (assuming the moment referred to is torsion). Cygna has checked the calculations in their scope and finds that, in each calculation, the moment used as torsion for the Richmond insert is the moment at the concrete, which tends to support the use of 7". However, Cygna has not been able to match all the data in Table 1 (Part B) against the calculations. For example:

  A. MS-1-002-013-C72K (Drawing Revision 9, Calculation Revision 7 dated 2/20/84), sheet 33:

     Tension = 15.4 kips (Table 1 = 23.975 kips)
     Shear = 8.94 kips (Table 1 = 4.301 kips)
     Torsion = 44.7 in-kips (Table 1 = 3.295 in-kips)

  B. MS-1-002-006-C72K (Drawing Revision 7, Calculation Revision 6 dated 12/20/83), Sheet 17:

     Tension = 4.069 Kips (Table 1 = 4.069 kips)
     Shear = .455 Kips (Table 1 = .455 kips)
     Torsion = 5.676 in-kips (Table 1 = 2.048 in-kips)

  Please clarify where the data in Table 1 is taken from and how the moment reported in Table 1 correlates to the torsional moment obtained from the tests.

ATTACHMENT
(continued)

- TUGCO performed the tests in the absence of an applied tension load. TUGCO should justify that the tests do envelope the possible combinations of tension, shear and torsion exhibited by the supports.
- In performing the torsion tests, TUGCO welded a plate to each open end of the short piece of tubesteel (item 3, Attachment F-4). These plates stiffen the tubesteel against the applied torsion and may not give results representative of field conditions. Please justify that the configuration tested does represent the actual effect of the tubesteel on the bolt, especially in regards to prying.

3. For tubes subjected to both force perpendicular to the axis of the tube (i.e., pullout on the bolts) and torsion, Cygna reviewed the TUGCO finite element analyses results concerning release of the bending moment restraint at the bolt as an appropriate modeling technique. The analyses results show that the tube deflection due to bolt elongation and tube deformation exceeds the calculated tube end displacement due to rotation at the STRUDL pin supports, which would justify TUGCO's assumption. Cygna has, however, two items requiring clarification:
   - There appears to be text missing in the Affidavit between pages 33 and 34. Please provide the missing text.
   - On the second page of Table 2 of the Affidavit, the bolt interaction for two supports (FW-1-095-700-C62K and FW-1-098-700-C62K) increased when moment M_Z was released. Not only does this seem contrary to what one might expect, it is also contrary to the data shown for the Richmond insert interaction. Please explain this discrepancy between insert and bolt and, if the bolt interaction is correct, why the increase is reasonable.

4. In sizing the bolts for use with the inserts, TUGCO has neglected the possible bending stress in the bolt (i.e., bending due to treating the bolt as a beam). In standard bolt/baseplate connections, this bending is not considered since the bolt effectively acts as a shear member (in a bearing connection) or the shear load is taken by frictional forces between the concrete and plate (in a friction connection). In the TUGCO design, however, the shear load on the bolt may be offset from the concrete by the height of the tubesteel and the thickness of the washer plates, if any. Thus, a bending moment may be built up in the bolt which standard bolt design formulae do not consider. In addressing the concern of axial torsion (2 above) TUGCO's tubesteel/bolt test investigated this phenomena as pointed out in their affidavit. These tests showed a significant factor of safety when compared to TUGCO's method of considering bolt bending stress in the bolt design as described in their Affidavit. Cygna, however, has two concerns on TUGCO's evaluation of bolt bending stresses:

ATTACHMENT
(continued)

- In arriving at the 1.75 factor noted on page 25 of the Affidavit, TUGCO relies on a factor of 1.33 which is derived from a comparison of the finite element to hand calculated results in Appendix E-3. However, the finite element results are centroidal, not surface results. Thus, the longitudinal location of the bending moment in the bolt model is 1/8" from the end of the model. The radial location of the "average of element centroids" is not at the outer fiber, but at an interior location, since STARDYNE only reports stresses at the centroids of its solid elements. This underestimates the outer fiber stress by the ratio of outer fiber radius to centroidal radius. These errors may not have a significant effect on the TUGCO conclusions since the 1.75 is used as a cutoff ratio only and TUGCO does examine connections with higher interactions. TUGCO should comment on the effect of these errors.
- TUGCO does examine the bolt "bending stress" effect for one support (CT-1-053-408-C62R) with a high (4.12) interaction and shows a factor of safety greater than four when compared with the tubesteel/bolt test results. However, TUGCO does not address the supports with higher interactions, especially CT-1-054-430-C42R which has the highest interaction ratio shown in Table 1 or support CT-1-053-418-C62R which has 46 in-kips of moment. TUGCO should justify the factor of safety for connections with interaction ratios or loads higher than those addressed in the Affidavit.

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

February 8, 1985
84042.021

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 3 Open Items
Mass Participation and Mass Point Spacing
Comanche Peak Steam Electric Station
Independent Assessment Program
Job No. 84042

Reference: (1) L.M. Popplewell (TUGCO) letter to N. Williams (Cygna) "Cygna Potential Finding Report Mass Participation and the Mass Point Spacing Error in Problem AB-1-61A," Dec. 7, 1984

(2) R. E. Ballard (G&H) letter to J. B. George (TUGCO), "Mass Participation," GTN-69454, September 14, 1984

(3) N. H. Williams (Cygna) letter to J. B. George (TUGCO), "Phase 3 Open Items - Mass Particpation," 84042.017, September 21, 1984.

(4) N. H. Williams (Cygna) letter to J. B. George (TUGCO), "Phase 3 Open Items - Mass Participation," 84042.019, October 2, 1984.

Dear Mr. George:

Section 5.4 of the Independent Assessment Program Final Report states that Cygna's conclusions are contingent upon the satisfactory resolution of specified open items. A summary of TUGCO's completed actions with respect to two items, mass participation and mass point spacing, were provided to Cygna in reference (1) above. Cygna has reviewed the completed program and is submitting our comments for your review in this letter.

Before detailing any of the Cygna review results, a historical summary of major milestones and correspondence is useful in order to fully understand Cygna's perspective of the mass participation program. Originally, after a preliminary review of 5 stress problems, Gibbs & Hill submitted a plan to TUGCO in reference (2). Cygna reviewed the plan and approved it in reference (3), but noted that

more detail was needed before Cygna could comment on the adequacy of the screening criteria. Some of this detail was obtained during Cygna's visit to Gibbs & Hill on September 28, 1984. During that time, Cygna reviewed a portion of the work that had been done to date and the criteria that was being developed to evaluate the scope of the re-evaluation. Noting some apparent deviations to the Reference (2) plan, Cygna submitted a letter to TUGCO (Reference (4)) which contained a set of suggestions and concerns surrounding the implementation of the plan. These concerns would require consideration before Cygna would be able to close the mass participation issue.

The results of the study which TUGCO conducted to determine whether or not the inclusion of the missing mass had any significant effects on the pipe support loads were not formally documented as committed to in reference (2). However, TUGCO apparently concluded that further piping analysis was required since 205 of the 271 pipe stress problems associated with the CPSES Unit 1 design were eventually reanalyzed.

Cygna conducted their review of the completed program during the week of November 26, 1984 for both the pipe stress and pipe support disciplines. There were two points Cygna wanted to assess during that review: 1) the adequacy of the criteria used by TUGCO to determine when to stop reanalyzing stress problems, and 2) the thoroughness by which the pipe stress/pipe support reviews were conducted and documented. This letter contains the results of that last review and our recommendations for future action. It appears that TUGCO may not have understood Cygna's reference (4) comments and, as a result, a less rigorous criteria was developed than the one Cygna anticipated.

All of the reanalysis was done using Version D of ADLPIPE which permits inclusion of the missing mass or ZPA effect. In addition, Gibbs & Hill reviewed all 271 problems for the possible existence of mass point spacing/selection errors similar to those described in Cygna Phase 3 Observation PI-09-01. Table 1 provides a listing of all the piping problems and notes which problems contained mass point errors and which problems were rerun. The revised pipe support loads resulting from this reanalysis were then transmitted to the pipe support design groups for review and disposition.

In order to evaluate the pipe stress portion of the mass participation program, Cygna first reviewed the Gibbs & Hill work instruction for the piping reanalysis and found that it sufficiently addressed all aspects of the original Cygna finding. Then a sample of 32 stress problems were chosen in accordance with statistical sampling techniques described in MIL STD 105D for detailed reviews. This spot check was performed to ensure that Gibbs & Hill had properly implemented their procedure. Table 2 contains a list of the stress problems Cygna selected.

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Cygna found that Gibbs & Hill had considered the missing mass effect by re-running the problems with lowest participation. The reanalyses included all problems which had exhibited 30% or less mass participation plus all problems in which the systems were subjected to steam/water hammer loads. Gibbs & Hill then reviewed the results to ensure that piping stresses were within allowables. In addition, Gibbs & Hill reviewed all welded attachments on the Main Steam/Feedwater lines, based on the rationale that these are the most highly loaded systems. They also reviewed select penetration loads and valve accelerations for compliance with project criteria.

Following the reanalyses, Gibbs & Hill transmitted computer output sheets to the site which listed the original support loads, the new (i.e., corrected) loads and the percent increase. The two site lead engineers reviewed the output sheets and automatically approved any supports showing either load increases less than 5% (PSE /ITT Grinnell field group practice) or insignificant increases (NPSI field group practice) without reviewing the support package. This applied to all supports except the main steam/feedwater supports within NPSI scope, which were reviewed for any load increases. TUGCO engineers reviewed the remaining supports against the "mass participation" load increases. While TUGCO directed their engineers to use their standard design procedures in conducting their review, a work instruction or review procedure was not issued.

In order to review the pipe support portion of the mass participation program, Cygna selected 270 pipe supports from the approximately 1,100 pipe supports associated with the 32 pipe stress problems in the Cygna review sample. These supports represented 19 of the pipe stress problems. Cygna chose the supports to cover both PSE and NPSI site design scopes.

In reference 1 TUGCO has presented their position that the 205 reanalyzed problems represent a statistically significant sample which was biased towards the problems most likely to be impacted by the effects of missing mass. Since the reanalyses have shown that no piping problems were overstressed and no supports required modification, TUGCO has concluded that the remaining 66 stress problems need not be analyzed to close out the mass participation/mass point spacing issues.

The results of Cygna's review of reference 1 and the actual pipe stress and pipe support evaluations are presented below. In some instances the review was inconclusive since insufficient evidence existed to support the reference 1 conclusions.

Pipe Stress Results

1. Of the 66 stress problems not rerun to assess the effects of mass participation, 13 contained mass point errors of the type identified in Cygna Observation PI-09-01, i.e., failure to include a mass point between supports. Since a reanalysis of problem AB-1-61A during the Phase 3 reviews demonstrated that the addition of a mass point between supports may significantly affect the local support loads (300% increase in one support load), Cygna does not find sufficient justification for not reanalyzing these problems. Although these 13 stress problems have higher participation factors, it is not obvious how this compensates for the omission of mass points. While reference 1 presents arguements to support the mass participation sample, it does not attempt to justify the mass point spacing sample.

2. In the sample of 32 problems Cygna found three with mass point errors which were not included in the reanalyses models. These were:

   a. Stress problems 1-19A and 1-66B were missing a mass point between an anchor and an adjacent support.

   b. Although a Gibbs & Hill reviewer noted that a mass point should be included between two supports on problem 1-29V, this was not done in the reanalysis.

   Using a normal inspection acceptable quality level of 1.5, two errors constitutes a rejection. Although Cygna concurs with the methods Gibbs & Hill employed to address the mass point spacing issue, the methodology was not thoroughly executed.

3. Of the 66 problems not rerun to assess the effects of mass participation, 14 contained a mass point error with the input of concentrated weights in ADLPIPE Version C. Gibbs & Hill categorized concentrated weights as a mass point problem because they had independently discovered that ADLPIPE Version C did not lump these properly in the dynamic analyses. This program error was corrected in version D and thus was automatically accounted for in all reanalyses. Since neither Gibbs & Hill nor TUGCO have demonstrated in reference 1 or elsewhere whether this effect is significant, Cygna does not find sufficient justification for not reanalyzing these problems.

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4. Cygna found no evidence that the review considered the effects these reanalyses would have on the following areas of concern:

- Valve acceleration generic study (mentioned in reference 1 as "sampled")
- Flange loads generic study
- Welded attachments in break exclusion zones
- Areas with stress intensification factor errors as noted in Phase 3 Observation PI-00-01
- Functional capability for stainless steel elbows

5. The study of welded attachments only considered attachments to lines which are subjected to steam/water hammer loads. In these configurations, the seismic load is usually a small percentage of the total design load. Thus any increase in seismic loads is unlikely to impact design. It is more likely that other welded attachments may be affected significantly since they do not include steam/water hammer loads, and, thus, seismic loads represent a large percentage of the design load for those supports.

Pipe Support Review

1. In reviewing support RH-1-005-016-C42K for the new loads, Cygna noted that certain welds in the calculations dated 3/2/84 had a small margin. This support is a large gang hanger with three large bore supports (RH-1-005-016-C42K, -018, and -019), six small bore supports, and three conduit supports. The large bore support loads increased as a result of the mass participation study, as did two small bore support loads. The review for the new loads provided no calculations to show that the welds are acceptable. Cygna was unable to establish the acceptability of the welds through inspection.

2. Reference 1 indicates the support review is complete. Yet, Cygna's understanding from site personnel(as of November 30, 1984) is that much of the study work had neither been checked nor approved and, therefore, was not complete. In fact, for support AF-1-043-001-Y43R (Problem 1-156), the PSE reviewer noted that another design document, SA-4210, was still required to complete the review of this support.

3. Cygna did not find sufficient justification that relatively small load increases could be written off without inspecting the calculation. While many of the supports had large margins due to

originally conservative design loads, there were still some supports within Cygna's scope which exhibited very little margin such as described in item 1 above.

4. None of the calculations were updated to show the latest loads since TUGCO apparently considers these loads for study purposes only, not as loads of record. Cygna does not understand the justification for this position. If the preliminary assessment had demonstrated that the mass participation/mass point spacing observations were of no concern, then this is a logical position. Such a conclusion cannot be drawn since the mass participation/mass point spacing discrepancies do significantly affect pipe stress and pipe support margins. The analyses should be formally updated to reflect the corrected analyses.

5. Cygna did not find evidence that the effects of the errors noted by Cygna in Phase 3, (e.g., three-sided welds and incorrect composite section calculations) were accounted for during the pipe support load increase reviews.

6. Cygna did find that some supports had large margins, as described in reference 1, and that the original weld designs conservatively used 18 ksi versus an actual strength of 21 ksi.

Summary

Based upon Cygna's review of the mass participation study by Gibbs & Hill and TUGCO, there are a number of actions which Cygna recommends in order to properly close this issue. Some of these items arise from the fact that TUGCO is treating the results of the reanalyses as a study. Since the new loads are based upon more accurate analyses, Cygna feels that any increases in design loads due to the reanalyses should be incorporated as the design loads of record with complete documentation as required by the TUGCO quality assurance program. Only by doing this, will TUGCO ensure that any future evaluations of the piping or supports will be based on the latest information. This would avoid any possiblity of future judgements being formed using unconservative data.

In addition, since the use of 30% mass participation as a cutoff criteria does not meet the CPSES FSAR requirements, it is still necessary that evidence be furnished that would allow Cygna to conclude that the reanalysis of the remaining 24% of the piping problems to include the effects of missing mass would not result in any design deficiencies or significant reductions in margins. The fact that all problems with 30% or less mass participation in a

given direction were not reanalyzed does not eliminate any possible systematic error in the problem selection process. The selection process used by Gibbs & Hill does not provide any assurance that those problems which were not reanalyzed have a high percentage of supports with low margins. TUGCO had originally proposed to present a correlation between design margin and mass participation (reference 2). Reference 1 only presents a correlation of percent load increase or decrease to mass participation. It does not discuss mass point spacing at all, nor does it present any comparison for pipe stress results. Thus, it is difficult for Cygna to be reasonably certain that 76% of the problems reanalyzed envelop the potential support or stress margin reduction that would occur if the remaining 24% of the problems were reanalyzed.

In order to close this issue, Cygna recommends that TUGCO initiate the following actions:

1. Reanalyze the 13 stress problems which had missing mass points but were not originally rerun as part of the study.

2. Perform a review of all stress reanalyses to determine if they are missing mass points between an anchor and an adjacent support. This deficiency should be evaluated for its effect on the stress results.

3. Review all reanalyses to assure that all corrections specified by the Gibbs & Hill analysts have been incorporated.

4. Reanalyze the 14 stress problems which had concentrated weights input but were not originally rerun as part of this study.

5. Evaluate the effects of reanalyses on the following:

   - Valve acceleration generic study
   - Flange loads generic study
   - Welded attachments in break exclusion zones
   - Welded attachments in general
   - Areas with stress intensification factor errors as noted in Phase 3 Observation PI-00-01
   - Functional capability for stainless steel elbows

6. Provide evidence that 76% of the problems analyzed envelop the potential stress/support margin reduction that would occur if the other 24% of the problems not analyzed were analyzed.

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7. Revise the Gibbs & Hill as-built QA binders to reflect the latest analyses.

8. Revise the pipe support design calculations to reflect the loads from the reanalyses.

9. Incorporate the generic comments made by Cygna in the Phase 3 report (e.g., three-sided weld, composite section, welds in combination with bolts) into the support adequacy review calculations.

Overall, Cygna believes that the stress analysis portion of this study was reasonably well documented and executed. The ommissions noted appear to be more attributable to scheduling constraints rather than to lack of procedures or understanding of the engineering principles. On the other hand, the pipe support reviews were conducted without any procedures. The only evidence of completed support reviews for the load increases was a signature. In some cases the supports were too complex to use engineering judgment as a basis for acceptability in lieu of calculations, and therefore, calculations should have been performed. Also, we would like to emphasize that this analysis was necessary to bring the piping analysis into compliance with the FSAR. As such, it is Cgyna's opinion that the reanalysis should be the analysis of record.

Please call if you want to discuss these conclusions in greater detail.

Very truly yours,

N. H. Williams

N. H. Williams
Project Manager

cc: Mr. D. Wade
Ms. J. van Amerongen (telecopied)
Mr. R. Ballard
Mr. D. Pigott
Mrs. J. Ellis
Mr. S. Treby
Mr. S. Burwell (telecopied)

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TABLE 1

1 *M	29N *	46A M	62Y *M	77 M	96C *M	165E	2-67X M
2 *M	29O *	46B *	62Z *M	78 *M	96D *	165F *	2-68T
3 *M	29P *	47B *M	63A M	79A *M	97A *	165G	2-68X M
4 *M	29S	51A *	63C/B *M	79B *M	97B *	165H *	2-97D M
5 *M	29T	51C *M	63D *M	79C *	97C *	166A *	2-99A M
6 *M	29U *	51D *M	64A *M	79D *	97D *	166B *	2-99B *M
7 *M	29V *M	52U M	64B *M	79E *M	135A *	166C *	2-150F *
8 *M	29W *	52V *M	64C *	79F *M	135B	166D *	2-150G *
9A	29X *	52W *M	64D *M	80A *M	135C *	167A *M	2-150H *
9B *	29Y *	52X *	64E *	80B *M	135D *M	167B *M	2-150I *M
9C	29Z *	52Y M	64F *	80C *	135E	167C *	2-150J *
9D	30 *	52Z *	65 *M	80D *M	135F	167D *M	2-151 *
10A *M	31 M	55A *M	66A *M	81 *	150F *	167E *M	
10B *M	32 *M	55B *	66B *M	86A *M	150G *	167F *M	
10C *M	33 *M	55C *M	66C M	86B *	150H *	168 *M	
10D *	34A *M	55D *M	67T *M	86C *	150I *	169 *M	
11A *M	34B *M	57 M	67U M	87A M	150U *	170 *M	
11B *M	34C *M	58	67V *M	87B *	151A	171 *M	
11C *M	35A *M	59A M	67X	87C *	151B	172 *M	
12A *M	35B	59B *M	67Y M	88C *	151C M	174 *	
12B M	35C *	59C *M	67Z *M	88D *	151D *	175 *	
12D *M	35D	59D *	68T *M	88E *	152 *M	178A	
12E *M	35E *	60	68U *M	88W *	153 *	178B *M	
19A *M	35F *	61A *M	68V *	88X *M	154 *	179 *	
19B *	36 *M	61B *M	68X *M	88Y *M	155 *	180 M	
19C *	37B *	61C *M	68Y *M	88Z	156 *M	186	
21 M	37W *M	61D *M	68Z *	89 *M	157A	188 *	
23A M	37X *	61E M	69 *	90 *	157B *M	189 *	
23B M	37Y *	61F *M	70 *M	91 *M	157C M	2-51A *M	
23C M	37Z	62A *	71A	92A *M	158A *	2-51D *	
23D M	40	62B M	71B *M	92B M	158B *M	2-52B	
24 *	42A *M	62C *M	72 *	93A M	158C	2-52U *	
27 *M	42B *M	62D *	73 *	93B *M	163	2-61B *M	
28 *M	45Q *M	62E M	74 *	94 M	165A *	2-61E	
29K *	45R *M	62F	75 *	95 *M	165B *	2-62D	
29L *	45S *	62G M	76A M	96A *	165C *	2-63B M	
29M *	45T	62X *	76B M	96B *	165D *	2-67T M	

271 problems total
* = Problems reanalyzed in G&H N.Y. (203)
M = Problems with mass point spacing or concentrated wt. discrepancies (141)
*M = Reanalyzed with modifications to MP and or concentrated wt. (105)

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TABLE 2

Problems Reviewed by Cygna

AB-1-01	AB-1-67Z
AB-1-06	AB-1-68T
AB-1-10C	AB-1-68Y
AB-1-12A	AB-1-71B
AB-1-19A	AB-1-72
AB-1-28	AB-1-79A
AB-1-29V	AB-1-79F
AB-1-34A	AB-1-86A
AB-1-36	AB-1-88X
AB-1-42B	AB-1-95
AB-1-61A	AB-1-135D
AB-1-61B	AB-1-156
AB-1-63C/B	AB-1-167B
AB-1-64D	AB-1-171
AB-1-66B	AB-1-178B
AB-1-67V	AB-2-52U

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

February 12, 1985
84056.041

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

Subject: Cable Tray Support Review Questions
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 4
Job No. 84056

Dear Mr. George:

We have reviewed our correspondence and telecon files to ascertain the status of the cable tray support review questions asked to date. Attachment A contains a summary of currently unanswered cable tray support design review questions. Additional questions may be asked as we complete our documentation of the TUGCO/Gibbs & Hill responses to previous questions and evaluate the responses to the attached questions. Perhaps some of these questions and their relative effect on design adequacy may be answered more efficiently as part of the dynamic analyses being conductd on selected systems. Please advise us of any questions being addressed as part of that effort.

If there are any questions while preparing responses, please call.

Very truly yours,

N H Williams

N. H. Williams
Project Manager

NHW/rmk

cc: Mr. S. Burwell (USNRC)
Mr. S. Treby (USNRC)
Mr. D. Wade (TUGCO)
Ms. J. van Amerongen (EBASCO/TUGCO)
Mrs. J. Ellis (CASE)
Mr. R. Ballard (G&H)
Mr. R. Kissinger (TUGCO)

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

1. EMBEDDED PLATES

References:

(1) Gibbs & Hill Specification 2323-SS-30, Revision 1, "Structural Embedments," Appendix 4
(2) TRW Nelson Division, Design Data 10, "Embedment Properties of Headed Studs," 1977
(3) Gibbs & Hill calculations SCS-113C, Set 1, sheets 18-19, 42-46
(4) Gibbs & Hill drawing 2323-S-0919, Revision 3

Several cable tray supports within Cygna's review scope are attached to embedded strip plates. These supports are Types SP-7 with brace, SP-7 and Detail F (drawing 2323-E1-0601-01-S), which is similar to a multiple SP-7 support. Each of these supports consists of channel sections cantilevered from the embedded plate. These supports resist vertical, transverse, and, in the case of Detail SP-7 with brace, longitudinal tray loads. The connection between the cantilevered channels and the embedded plate is an all-round fillet weld. Such a connection provides full moment transfer.

The design of the embedded plates for the support types listed above was performed in 1979. In 1981, Gibbs & Hill specification 2323-SS-30 revision 0, "Structural Embedments," was issued. Appendix 4 of this specification lists the criteria and allowables for attachments to embedded strip plates. Revision 1 of this specification (Reference [1]) did not alter the criteria or allowables for embedded plates. Cygna has noted that the criteria listed in the referenced appendix are more stringent than those used in the original design of the embedded plates for the support types listed above.

Cygna requests a confirmation of the assumptions used in the generic embedded plate analysis. Gibbs & Hill has stated that a factor of safety of two was used in the analysis. Rigid plate assumptions as well as prying action effects were also considered. Cygna has calculated the allowable stud tensile loads based on values and reduction procedures reported in Reference (2) above and on a factor of safety of two. The values calculated by Cygna were identical to the allowable loads for point loadings applied along the plate centerline at stud points. This indicates to Cygna that prying action has not been considered in the development of embedded plate allowables.

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CABLE TRAY SUPPORT REVIEW QUESTIONS

With regard to the design of the embedded plate connections for the support types listed above, Cygna has noted several inconsistencies between the designs and the criteria reported in Specification 2323-SS-30, Revisions 0 and 1. The embedded plate connections that are used for the listed support details are moment resisting connections. Section 3.4 of Reference (1) above states that pin connections are to be used for load transfer to embedded plates. This section also requires that when a moment is to be transferred, the embedded plate connection must be stiffened. Further restrictions on moment transfer are listed in Section 4. Gibbs & Hill has stated that all moment connections must be evaluated per these sections. Cygna has not seen any evidence that such evaluations were performed for the cable tray supports listed above.

Sheets A4-1 through A4-9 of Appendix 4, reference (1), list the allowable values for various locations of applied point loads. Section 3.1 lists various reductions for locations other than those shown in the Appendix sheets 1-9. These reductions include interpolation of allowable values for attachment locations between the midspan and stud pairs along the longitudinal plate centerline. Interpolation of plate allowables is also required for attachment points between the longitudinal centerline and the stud lines at the plate edge. In addition, a 40 percent reduction is required for end-span loadings. It appears that none of the above reductions was considered in the design of the embedded plates for the listed details.

Section 3.3 notes that the full allowables shown on sheets A4.2 and A4.4 are applicable only when the attachment is within ± 3/4 inches of the longitudinal plate centerline. The centerline tolerances allowed in References 3 and 4 for beam connections of Details SP-7 and SP-7 with brace, are 1-1/2 inches and 2-1/2 inches for eight and ten inch plates, respectively. A 1-1/2 inch tolerance is allowed for the brace connections of Detail SP-7 with brace. These tolerances exceed those specified in Section 3.3, even though the full allowables were used.

Please provide Cygna with the following:

1. Documentation which evaluates the effect of prying action on embedded plates and studs;

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

2. Documentation and justification for the acceptability of the moment connections for Details SP-7, SP-7 with brace and Detail F; and

3. Documentation which verifies that the details listed in question 2 above meet the criteria set forth in Appendix 4 of Reference 1.

2. AFFECT OF TWO-INCH THICK ARCHITECTURAL TOPPING ON HILTI BOLT EMBEDMENT LENGTH

References:

(1) TUGCO SDAR-CP-80-05 dated 8/8/80
(2) Brown & Root Instruction CEI-20, Revision 9
(3) CMC 6114, Revision 4, dated 10/12/83, Support No. 2998
(4) CMC 85720, Revision 0, dated 2/2/83, Support No. 13080

Two cable tray supports within Cygna's review scope, support numbers 2998 and 13080, use floor mounted base plates. These supports are located in areas where 2" thick architectural topping is present. A walkdown was performed to verify that sufficient Hilti anchor bolt embedment was provided. Based on the length code stamped on the exposed ends of the installed Hilti Super Kwik bolts and the measured projection, (i.e., the distance from the floor slab to the top of the bolts), the bolts installed are not of sufficient length to provide the minimum embedment specified in References (3) and (4) for these supports.

Cygna calculated minimum embedment length before torquing for these two supports as follows:

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Embedment = (bolt length) - (topping) - (bolt projection) + (nut thickness)

Support No.	Bolt Code	Bolt Length	Projection Above Slab	Minimum Embedment Calculated	Required
2998	U	13"	4-3/8"	7-7/8"	8-1/2"
13080	X	16"	4-1/4"	11"	13-1/8"

Cygna was provided with a copy of Reference (1) above, when this concern was first discussed with TUGCO. The corrective action indicated in Reference (1) requires a case-by-case evaluation of all Hilti bolts installed in areas with two-inch topping. Cygna interprets this as applying only to bolts installed before the date of Reference (1). Since both floor mounted supports within Cygna's scope were installed after that date, they would not have been included in the evaluation.

Reference (1) also indicates that Reference (2) above was revised to reflect the effect of topping on embedment length. Section 3.1.7.1.2 of reference (2) states:

> "Expansion bolts which have less than the specified designed embedment length into structural concrete but greater than the values indicated above in 3.1.7.1.1 shall be evaluated by the responsible design engineer. If found to be acceptable "as-is," appropriate design change documents shall be issued. If found to be unacceptable, the expansion bolt shall be reworked in accordance with 3.1.7.1.1 a or b."

Assuming that this criteria was followed for the installation of support numbers 2998 and 13080, the Quality Control inspection travelers should show that the "specified designed embedment length" was not met, and that an evaluation was performed by the "responsible design engineer."

Please provide copies of the existing design change documentation for these supports indicating the acceptability of the reduced embedment length. If no documentation exists, please assess the impact of this issue on other floor mounted supports in the areas where two-inch topping is used.

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3. CONTROLLING LOAD CASE FOR ONE-BOLT BASE ANGLE ANALYSIS

References:

(1) Gibbs & Hill Drawings: 2323-S-0903, Detail 1
2323-S-0908
2323-S-0909
(2) Conference Report dated 11/14/84, 2:15 p.m.; Bhujang, Chang, Berry, Horstman and Russ
(3) TNE Calculation by J.C.C. dated 11/15/84, "Investigation of Single Clip Angle"
(4) Gibbs & Hill Calculation Binder SCS-215C, Set 4

During the discussion regarding the analysis of Detail 1, one-bolt base angle connections, as noted in Reference (2) above, Gibbs & Hill was to determine the controlling load case for this connection, i.e., the maximum loads. The calculations provided, Reference (3) above, use the loads from a B-2 type support, but do not provide any comparison to show that this is the controlling case. Based on Cygna's review of existing calculations, it appears that other support types may develop larger loads for this connection detail. An example of a support type with larger loads is case E-4, per Reference (4) above, sheets 16-20.

Please provide documentation indicating the controlling load case for the one-bolt base angle and an analysis considering these loads.

4. WORKING POINT DEVIATION CALCULATIONS

Cygna has reviewed the Gibbs & Hill working point analysis performed in March and April 1984. This review identified problems with boundary conditions (unjustified restraint of frames in the longitudinal direction) and the effects of closely spaced modes. Gibbs & Hill revised the working point analysis to correct these discrepancies and resubmitted them to Cygna for review. Based on discussions with site personnel, Cygna understands that any work associated with the closure of the working point study has been suspended until the NRC mandated as-built program is completed. Cygna, however, has concerns about the analysis

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

and its application which would not be addressed by an as-built program alone.

The working point study establishes cut-off elevations below which the supports may be considered acceptable for given working point deviations. This evaluation is based on assumed accelerations, 8'-6" tray spans, enveloping aspect ratios, and maximum permissible working point deviations. Above these elevations, Gibbs & Hill evaluated the supports on a case-by-case basis using design documents only. No consideration was given to trays where the unit weight exceeded 35 lb/sf due to added fire protection or to the as-built support configuration as reflected by applicable CMC's and DCA's. Cygna has identified spans up to 12 feet (reference Cygna letter 84056.019 dated 8/10/84) in length which indicates that there would be a problem in justifying the qualification of trays below a given elevation using an assumed 8'-6" span. Further, for supports located above the cut-off elevation where the map drawing shows spans greater than 8 feet, an additional 6" installation tolerance must also be considered.

The effect of possible variations in aspect ratio, fire protection weight and actual working point deviations must be considered in the same manner as the above concerns regarding span violations. Further, Quality Control's use of a working point deviation criteria as the sole means of ensuring compatibility with the Gibbs & Hill analysis will not unto itself ensure design adequacy.

Please indicate the plan of action TUGCO will use to resolve this issue.

5. <u>DETAILS F-H, DRAWING 2323-E1-0601-01-S AND SP-7, EFFECTS OF SMALLER WELD SIZE AND UNDERRUN</u>

Reference:

(1) Conference Report dated 11/17/84, 8:00 a.m.; Chang, Huang, Horstman, Russ and Williams

From the referenced conference report:

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

"Cygna has reviewed the Gibbs & Hill calculations which address the change in fillet weld size (3/16" vs. 1/4") for Details F-H. Cygna has noted that when the effects of eccentric loads are considered, the welds appear to be overstressed. The Gibbs & Hill calculations did not consider these effects. Gibbs & Hill inquired if the member was also overstressed. Cygna responded that for a 4'-9" cantilever length details SP-7 and F-H there is a resulting 4% overstress. Cygna provided the following list of details which appear to exhibit overstress conditions in the weld and/or member.

For 3/16" fillet weld without underrun:

(a) Details F-H without brace with 30" tray and maximum moment arm.
(b) SP-7 attached to embedded plate with 24" and 30" trays.
(c) SP-7 with brace attached to embedded plate with 24" and 30" trays. (Gibbs & Hill noted that allowable tray spans for embedded plates is 7'-6".)
(d) Details F-H attached to embedded plate with 24" and 30 " trays.

For 3/16" fillet weld with 1/32" underrun for all tray sizes:

(a) Details F-H.
(b) Details F-H attached to embedded plate.
(c) SP-7 attached to embedded plate.
(d) SP-7 with brace attached to embedded plate.

Potential member overstress examples include:

(a) Details F-H with 30" tray.
(b) Details F-H attached to embedded plate.
(c) SP-7 attached to embedded plate.
(d) SP-7 with brace attached to embedded plate."

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Please indicate the plan of action TUGCO will use to address the potential weld and member overstresses indicated above.

6. WELD DETAIL FOR CONNECTION OF CHANNELS TO CLIP ANGLES

References:

(1) Gibbs & Hill Drawings: 2323-S-0901
2323-S-0902
2323-S-0903
(2) Brown & Root Drawing FSE-00159
(3) Conference Report, dated 11/17/84, 8:00 a.m.; Chang, Huang, Horstman, Russ and Williams
(4) Conference Report, dated 12/19/84, 9:30 a.m.; Keiss, Warner, Mercer, van Amerongen, Horstman and Russ
(5) Gibbs & Hill Calculation Binder SCS-215C, Set 2
(6) Gibbs & Hill Calculation Binder SCS-122C, Set 3
(7) Gibbs & Hill Calculation Binder SCS-146C, Set 1
(8) CMC 82988, Revision 0, dated 11/15/82, Revision 1, dated 3/7/83 and Revision 2, dated 7/11/84
(9) DCA 20228, Revision 0, dated 4/10/84 and Revision 1, dated 4/30/84
(10) RFIC EH-1842, dated 11/5/82

A review of the cable tray support design drawings, Reference (1), showed that no minimum length is specified for the weld attaching a support channel to the angle section used as a base plate. Support types for which the weld length is not specified include Details 1, 4, B, C, D, Case SP-7 plan, etc. The hanger assembly drawings, Reference (2), typically indicate the distance between the face of concrete and the end of the channel to be 1-1/4", but specify no tolerance for this dimension. The 1-1/4" dimension results in a 3-3/4" lap between the channel and an L5 x 5 x 3/4.

Referring to the discussion in Reference (4), TUGCO indicated that the 1-1/4" dimension was used as a maximum distance for installations where the channel was attached on the outside of the angle (Type II). It was also

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

used as a minimum distance for installations where the channel was attached on the inside of the angle (Type I). (Due to the internal radius on the angle, a member can not be attached any closer than "k" from the heel of the angle, e.g., k = 1-1/4" for L6 x 6 x 3/4 and L5 x 5 x 3/4.) If the channel laps into the fillet at the corner, it does not lie flat against the leg of the angle and a gap will result. Mr. Warner assured Cygna that the weld fit-up inspection prevents this from occurring and that the weld inspection assures that the proper weld, including end returns, is installed.

If 1-1/4" is used as the minimum distance for Type I connections, the resulting weld length could be less than 3-3/4". In Gibbs & Hill's evaluation of weld size underrun, a weld length of 3-3/4" was used per Reference (6) for the standard connection details and per Reference (7) for SP-7 and SP-7 with brace. The use of a shorter weld length could result in an overstress in the welds used in this detail. Per Reference (10), clarification on this matter was requested by site personnel and as a result CMC 82988 [Reference (8)] was issued to give specified tolerances on the connecting weld length. CMC 82988 was issued in November 1982, by which time the majority of the Unit 1 cable tray supports had already been installed.

Further review by Cygna noted that due to the radius at the toe of an angle section, a gap will exist between the web of a channel and the angle section at the toe. (See Figure 1.) In order to achieve a 3-3/4" weld length and the necessary return, the fillet weld must bridge this gap. Cygna believes that without the use of a special welding procedure, a fillet weld will not achieve its full effective throat at this location, and thus the weld section properties will be less than considered in the design calculations.

Plese provide the following:

- The documentation from engineering used by Brown & Root to establish the 1-1/4" distance between the face of concrete and the end of channel shown on FSE-159 drawing sheets. This was previously requested in the Reference (4) conference report.

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

- The installation tolerance for the connecting weld length that was used prior to the issuance of CMC 82988 and provide assurance that a minimum weld length of 3-3/4" was always provided.

- The welding procedure which applies to performing a fillet weld over the gap between the channel and the toe of the angle section or documentation to show the acceptability of the connection.

7. <u>WELD DETAILS AFFECTED BY GENERIC CHANGE DOCUMENTATION</u>

References:

(1) CMC 58338, Revision 0
(2) Gibbs & Hill Calculation Binder SCS-122C, Set 3
(3) Conference Report dated 11/17/84, 8:00 a.m.; Chang, Huang, Russ, Horstman and Williams

As discussed in the referenced conference report, Cygna indicated that in order to evaluate the effect of the use of 1/4" fillet welds for cable tray support fabrication, generic CMC's and DCA's which address changes in welding requirements must be reviewed. Cygna provided a list of CMC's and DCA's affected by this concern, but noted that the list should be checked for completeness.

During additional review, Cygna located CMC 58338, which may be effected by this concern. This CMC allows an alternate weld pattern to be used for the connection between the beam and hanger members. An evaluation of the weld pattern using a horizontal run along with top and bottom flanges of the (C x 7.25 results in an approximate 20% reduction in the torsional modulus compared to the value used in the weld evaluation per Reference (2). The CVC for this CMC indicates that no calculations were required.

Please provide the following:

- Justification for the adequacy of this alternate weld pattern, taking into account the potential of weld size underrun and the use of 1/4" weld size for this connection detail.

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- The status of Gibbs & Hill's investigation into the effect of the reduced weld size on the design review of the generic CMC's and DCA's for weld details.

B. INSTALLATION TOLERANCES FOR CABLE TRAY SUPPORTS

References:

(1) DCA 20228, Revision 1
(2) DCA 9738, Revision 3
(3) Specification 2323-SS-16B

DCA 9738 provides the following revision to specification 2323-SS-16B:

9.6 TOLERANCE:

9.6.1 In general, all structural steel work shall be plumb and level within the tolerance 1:500.

9.6.2 Hangers for electrical raceway systems shall be installed within following tolerances. The cumulative effect of rolling (mill), fabrication and erection tolerances shall not exceed those given below:

- A hanger shall be considered plumb if the angle between the longitudinal axis of the main member(s) of the hanger is at right (90°) angles to the supporting surface (ceiling or floor). A tolerance of ± 2°, unless otherwise noted, shall be acceptable provided the integrity of the supported raceway system and its attachments to the hanger remains intact.
- Hangers supported on vertical surface (wall, column, side of a beam, etc.) shall be considered level with maximum tolerance of 1/2" in 10 feet.

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

- Use of extreme boundaries of such tolerances may be at times aesthetically unacceptable and the owner or its representative may provide stricter tolerances on case by case basis.

Cygna is concerned by the potential effects of the ± 2° tolerance for the plumbness of the hanger on the axial load carrying capacity of the member. For a typical 12'-0" high support, 2° slope results in a 5" offset of the lower end of the hanger. This offset could result in additional bending stresses in the vertical members when axial loading is considered.

Please provide the following:

- A copy of the design review calculations for DCA 9738 considering the effect of the 2° tolerance on support design.
- The procedure used by the responsible engineer to determine if a finer tolerance is needed to assure that the "integrity of the supported raceway system and its attachment to the hanger remains intact."

9. DETAIL "5", DRAWING 2323-S-0905, SUPPORT NO. 3136

References:

(1) CMC 8229, Revisions 0 - 13
(2) Gibbs & Hill Calculation Binder SAB-1341, Set 3

Cygna review of the "Design Review" Calculations for CMC 8229, Reference (2), indicated that there are several potential errors in these calculations. Cygna provided a list of questions and comments, pertaining to these calculations, to Mr. B. K. Bhujang on October 20, 1984. No response has been received from Gibbs & Hill.

Please provide Cygna with the status of this review.

ATTACHMENT A
CABLE TRAY SUPPORT REVIEW QUESTIONS

10. DETAIL "H", DRAWING 2323-E1-0601-01-S, SUPPORT NO. 734

References:

(1) Brown & Root Drawing FSE-00159, Sheet 734
(2) CMC 164, Revision 4
(3) Conference Report, dated 10/27/84, 9:15 a.m.; Keiss, van Amerongen, Chang, Huang, Russ, and Williams

Responding to the discussion in the referenced conference report, Cygna noted that this support has deviated from the generic design for detail H without brace by rotating one of the channels 90° from the standard orientation. Heavy duty clamps were installed per Reference (2). No consideration was given to the additional of longitudinal loads to this support. The conclusion from Reference (3) was for TUGCO to provide Cygna with calculations evaluating this support's as-built condition.

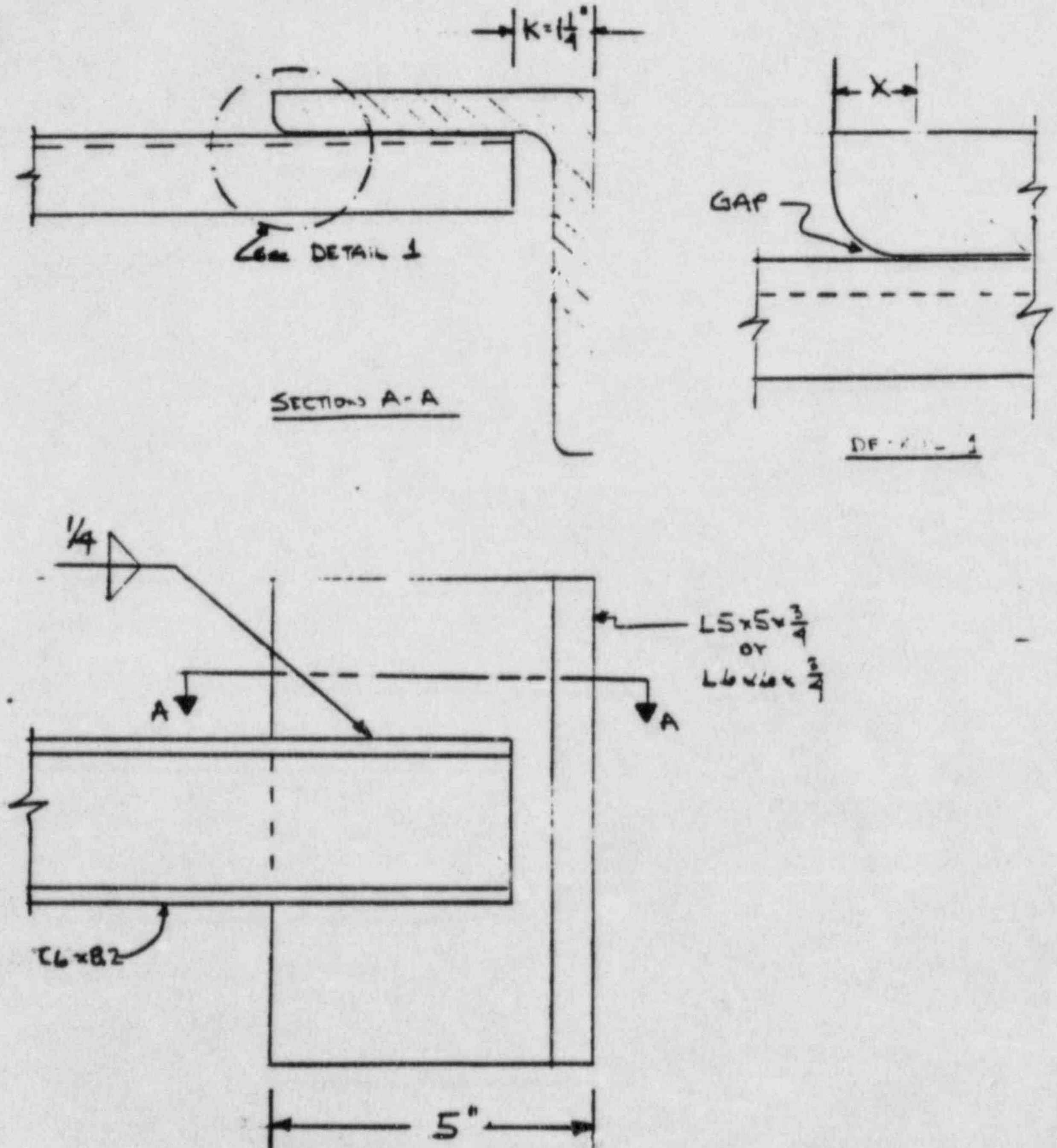
Please provide the calculations generated by TUGCO in response to the discussion.

CYGNA

Calculation Sheet

Project: Texas Utilities CPSES IAP Phase 4	Prepared By: B. Horstman	Date: 12-14-84	
Subject: Cable Tray Support Review	Checked By:	Date:	
System:	Job No: 84056	File No:	
Analysis No:	Rev. No:	Sheet No:	

FIGURE 1 WELD BETWEEN CONNECTION ANGLE AND TRAY HANGER



CYGNA
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

ATTACHMENT
(Revision 1)

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 ($\beta \cong .6$). 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.

CYGNA
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415 397-5600

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.

~~8502010348~~
4/18.

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

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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ATTACHMENT

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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ATTACHMENT

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 ($\beta \equiv .6$). 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.