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

August 17, 1984
84056.022

Mr. J. B. George
Project General Manager
Texas Utilities Generating Company
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:

Attachment A contains additional cable tray support review questions. If there are any questions while preparing responses, please call.

Very truly yours,

N. H. Williams

N. H. Williams
Project Manager

NHW:jm

cc: Mr. S. Burwell
Mr. S. Treby
Mr. D. Wade
Mr. G. Grace
Mrs. J. Ellis
Mr. R. Ballard

50-445/446

H001
1/1

ADD: NSIC
REGION IV

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

1. Case A_1 Support Numbers 2607 and 657

Reference:
(1) Gibbs & Hill Calculation SCS-101C, Set 1
(2) Gibbs & Hill Drawing 2323-S-0901

The design calculations of Regular Case A_1 supports specify an allowable range for support height (H) of $14" \leq H \leq 28"$ and a maximum width of 72". Support 2607 has a height of 54" which exceeds the allowable by 26". Support 657 is 84" wide, 6" larger than the allowable.

Please provide documentation on the capability of supports 2607 and 657 to resist applied loads.

2. Regular Case A_2 Support Numbers 2992, 2994, 3005, 3017, 3021, 3111, 6654

Reference:
(1) Gibbs & Hill Calculation SCS-101C, Set 1
(2) Gibbs & Hill Drawing 2323-E1-0713-01-S, Revision 3
(3) Gibbs and Hill Drawing 2323-E1-0713-11, Revision 5
(4) Calculation SCS-137C, Set 2, sheets 10-11

The supports listed above are noted on reference 2 as "A_2 (except all members to be MC6 x 12), L = 8'-3", h = 4'-2"." Reference 3 notes that these supports restrain 1 - 18" and 2 - 30" cable trays. Reference 1 lists the maximum support width and total supported tray width for Regular Case A_2 supports as 72" and 48", respectively. The total tray width and the support width exceed the allowable by 30" and 21", respectively.

In addition to the instances noted above where allowables have been exceeded, hanger assembly drawings sheets 2992, revision 2 and 3005, revision 2 (for the respective supports) of drawing FSE-00159, call out the beams as C4 x 7.25 sections and the hangers as C6 x 8.2 sections. These drawings sheets contradict the requirement for all members to be MC6 x 12 sections as quoted above from reference 2.

CMC 30452 indicates that one hanger of support number 3021 shows a common base angle with support 2946. Design verification calculations for the CMC appear in reference 4. The calculations do not consider applied shear loads or prying effects. Because shear loads are neglected, no interaction ratio is calculated.

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

Please provide Cygna with justification and documentation for the following:

(a) Ability of the seven (7) supports listed above, whose supported tray width and specified support width are greater than their rated allowables to resist the applied loads.

(b) That the correct member sizes (MC6 x 12) were used for support mumbers 3005 and 2992.

3. Case A_4 Support Numbers 202, 290, 2986

Reference:
(1) Gibbs & Hill Calculation SCS-101C, Set 1
(2) Gibbs & Hill Drawing 2323-S-0901

Support 290 is modified per CMC 30282 by relocating the uppermost diagonal brace such that the brace-hanger working points are eccentric to the beam-hanger working points. It is Cygna's belief that the noted eccentricities will introduce additional bending moments into the hangers at the new location of the brace-hanger working points.

Please provide Cygna with justification and documentation for the ability of support 290, modified as described above, to resist the applied loads.

4. Case B_4 Support Number 408

Reference:
(1) Gibbs & Hill Calculation SCS-101C, Set 1
(2) Gibbs & Hill Drawing 2323-S-0901

Cygna noted that 58" was used for the unbraced length in the calculation of the slenderness ratio for the hanger member. The actual unbraced length is the distance to the first level of trays which is 130". Use of the larger value results in a slenderness ratio (kl/r) of 242 which exceeds the allowable value of 200 per AISC code section 1.8.4.

On sheet 104 of the referenced calculation, the concrete anchorage is checked for adequacy when the effects of prying action are considered. The check is performed by assuming that a compressive force is developed at the end of the base angle to increase the moment arm resisting the effects of the lateral loads. The assumption that a compression block is developed indicates that the base connection provides moment restraint. Thus, the assumption of a moment resisting base connection contradicts the initial analysis assumption that the base connections for hangers are pinned

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

joints. Cygna also notes that the referenced check for prying effects is not applicable to one bolt base connections.

Support 408 was modified per CMC 9916 due to interferences with piping and a heat exchanger. The primary modifications involved removal of the two diagonal braces and changing the south hanger attachment to a shear type base connection attached to the side of a concrete beam. In Cygna's opinion, these modifications are so extensive that this support will no longer be qualified by the original design calculations for Regular Case B_4 supports.

A one page calculation from calculation binder SCS-138C, Set 1, sheet 11, evaluating the modified support configuration is attached to the CVC for CMC 9916, Revision 1. The calculation evaluates only the bending stresses in the two lower beams. No evaluation of the modified base connection was made. It is Cygna's contention that the support as modified requires evaluation for the effects of lateral loads on the hangers and on the modified base connection.

Please provide justification and documentation for:

(a) The use of an unbraced length other than the actual;

(b) The effects of using the actual unbraced length on the ability of the support to resist the applied loads;

(c) The assumption of a moment resistant base connection to qualify a connection originally assumed as a pin; and

(d) The ability of support 408 as modified per CMC 9916 to resist the applied loads.

5. <u>Regular Case SP-4; Support Numbers 638, 3026</u>

References:

(1) Gibbs & Hill Drawing 2323-S-0903
(2) Gibbs & Hill Calculation SCS-101C, Set 3
(3) Gibbs & Hill Drawing 2323-E1-0713-01-S, Revision 5

Cygna's review noted that on Sheet 91 of reference 1 the analyst assumed the end conditions for member AB to be fixed for the longitudinal and vertical loads analysis. The use of this assumption also requires that the fixed-end moments be considered in the analysis of members AE and BD. No consideration of the moment transfer to members AE and BD was made in the analysis.

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

The frame analysis also considers the elevation specific accelerations as well as a 25% reduction in the applied vertical loads. No substantiation of the vertical load reduction was provided. The frame analysis also included a stress check based on the following equation:

$$f = [f_a^2 + f_{bx}^2 + f_{by}^2]^{1/2} \leq 22 \text{ ksi}$$

In Cygna's opinion the combination is incorrect for two reasons:

(a) The axial stress is compared to the allowable bending stress; and,

(b) Standard AISC code interaction equations 1.6-1a, 1.6-1b and 1.6-2 are applicable.

The brace design appears on sheet 94 of reference 2. The design does not consider moments induced through the fixed connection at the frame. These moments would also be induced into the anchor bolt connections but were not considered. In checking the adequacy of the member, a comparison is made between axial force and allowable axial stress. A proper comparison would require checking applied and allowable stresses.

Members AE and BD are connected to the concrete via anchor-bolted clip angles. As noted above, the effects from fixed end connections on member AB are not considered in the design of members AE and BD. Since such loads are ignored, the shear loads on the anchor bolts due to torsion from members AE and BD are not included in the evaluation of the bolt capacity.

Support 3026 is specified as a "Case SP-4, omit brace" in reference 3. The tray assembly drawing (drawing FSE-00159, sheet 3026, revision 5) specifies a brace. Cygna's walkdown indicates that a brace has not been installed and that support 3026 was located at a tray elbow. Cygna's walkdown also noted that the tray segments T12ØABC15 and T12ØABC16 are supported longitudinally by support 3026. The direction of this longitudinal load is perpendicular to the direction (but in the same plane) of the analyzed longitudinal loads. The effect of the loads on support 3026 from the trays listed above will be an increase in the transverse load used in the original support design. Cygna was unable to locate any calculations verifying the adequacy of the support with the brace removed and considering the effects of the imposed loads from cable trays T12ØABC15 and T12ØABC16.

Please provide Cygna with justification and documentation for:

(a) The suitability of assuming fixed ends for member AB without considering the effects throughout the remainder of the frame including the anchor bolts;

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

(b) The suitability in reducing vertical loads by 25%;

(c) The use of interaction equations other than those specified by the AISC code;

(d) The capacity of the angle brace when considering the effects due to fixed end moments;

(e) The acceptability of checking an applied force against an allowable stress;

(f) The capacity of the brace connection base angle to resist the moments carried through the brace due to brace fixity; and,

(g) The capability of support 3026 to resist the applied loads including those induced by the listed tray sections above.

6. Regular Case D_1; Support numbers 2861, 3025 and 3028

References:
(1) Gibbs & Hill Drawing 2323-S-0901
(2) Gibbs & Hill Calculations SCS-101C, Sets 1 and 3

The original design calculations for Regular Case D_1 specify a maximum total tray width of 48" and a maximum support width of 96" assuming the use of a C4 x 7.25 section for the beam member. In the field, two 30" trays and one 18" tray are supported or a total tray width of 78". The support width for the supports listed above is 135" which exceeds the allowable width by 39". The support drawings for 3025 and 3028 specify an MC6 x 16.3 section for the beam members. The support drawing for 2861 also specified an MC6 x 16.3, but the section was later modified to a tube steel section. The design calculations for the connection of the beam to the concrete wall considered only the shear and tension from the vertical and transverse loads and ignored the bending moment which resulted from the beam analysis.

The beam members were originally analyzed as propped cantilevers with moment fixity at the wall connection. The design of the beam connection to the concrete wall did not consider the bending moments resulting from the fixed end assumption. The concrete connections for the hanger and beam were both originally designed for a total tray width of 48".

As noted above, the beam member of support 2861 was originally designed using a C4 x 7.25. The hanger drawing specified an MC6 x 16.3 which was later modified to a TS6 x 3 x 5/16 per CMC 53778. This CMC also noted that

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

the hanger member was notched to accommodate a piping interference. Calculations attached to the CVC for CMC 53778, Revision 1 analyze the beam for a 7'-0" tributary span of tray. According to Cygna's walkdown results, the tributary span should be 8'-4". The beam member is also analyzed assuming partial moment fixity of both beam ends. The use of this assumption requires consideration of moments due to fixity in an evaluation of the hanger and the beam connection to the concrete wall. No analysis of the hanger was performed considering the effects of induced moments, increased tray loads, and the effect of the notch.

Cygna's review of CMC 53778 noted that a 3/16" fillet weld was used in the connection of the tube steel section to the base angle. The use of this weld size is an apparent violation of AISC Code section 1.17.2.

Please provide Cygna with justification and documentation for:

a) The capability of the generic beam-concrete connection to resist the design loads;

b) The increase in support width and total tray width as well as the substitution of an MC6x16.3 for supports 3025 and 3028. Please address the capability of the supports to resist the applied loads;

c) The capability of support 2861 to resist the applied loads considering the effects of the notched hanger and the increase in support and tray width; and,

d) The suitability of using a weld size which is an apparent violation of AISC Code section 1.17.2.

7. Regular Case D_2; Support Number 124

References:
(1) Gibbs & Hill Drawing 2323-S-0903
(2) Gibbs & Hill Calculations SCS-101C, Set 1

The calculations in Reference 2 note that a bending moment occurs at the connection of the beam to the concrete. In the check of the generic base angle configuration, this moment is ignored and only shear and tension due to vertical and transverse loads are considered.

The base angle was modified per CMC 1078 to span an existing opening. Calculations to evaluate the effects of the modification on the anchor bolts are attached to the CVC for CMC 1078. These calculations did not consider the moments resulting from the beam's fixity nor do they include an increase in tensile loads due to prying action.

ATTACHMENT A

**CABLE TRAY SUPPORT
REVIEW QUESTIONS**

Please provide Cygna with justification and documentation for:

(a) The capability of the generic beam-concrete connection to resist the design loads; and

(b) The capability of the beam-concrete connection of support 124 to resist the applied loads.