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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
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)

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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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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;

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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	Minimum Embedment 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

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

Reference:

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

From the referenced conference report:

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"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

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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,

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- 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. WELD DETAILS AFFECTED BY GENERIC CHANGE DOCUMENTATION

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.

8. 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 maximun tolerance of 1/2" in 10 feet.

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- 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.

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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

C culation Sheet

Project TEXAS UTILITIES CPSES IAP PHASE 4		Prepared By B. HOUSMAN	Date 12-14-94
Subject CABLE TRAY SUPPORT REVIEW		Checked By	Date
System		Job No 94056	File No
Analysis No	Rev No	Sheet No	

FIGURE 1 WELD BETWEEN CONNECTION ANGLE AND TRAY HANGER