CYGNA
ENERGY SERVICES

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August 21, 1984
84056.025

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

Subject: 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 (US NRC)
Mr. S. Treby (US NRC)
Mr. D. Wade (TUGCO)
Ms. J. Van Amerongen (EBASCO/TUGCO)
Mrs. J. Ellis (CASE)
Mr. R. Ballard (G&H)

ADD: REGION IV
NSIC

H001
1/1

1. Detail SP-6; Support Numbers 360 and 3011
References: (1) Gibbs & Hill Calculation SCS-101C, Set 3
(2) Gibbs & Hill Drawing 2323-S-0903

The original design calculations (reference 1) analyzed and designed the frame and the anchor bolts separately. The frame analysis was based on a given range of heights and widths while the anchor bolt design was based on a separate range of heights and widths. In the calculations for the frame, the anchor bolts were not checked and in the calculations for the bolts, the frame members were not checked. It is not clear to Cygna which limiting range of height and width values is applicable for the cable tray support.

The design calculations for Detail SP-6 considered the support to be a moment-resisting portal frame with fixed joints at the beam-concrete connections. The frame was analyzed consistent with this assumption using moment distribution. The anchor bolts and the base angle used in the connection were not designed to resist such fixed-end moments, but were designed as if the frame was pinned supported. The anchor bolts were designed to resist applied tension and shear loads. The connection configuration is such that the anchor bolts will be subjected to shear loads only. Allowable hanger eccentricities from the centerline of the anchor bolts were calculated, but the formula used in the calculation is for connections which are subject to shear and tension loadings. A one-bolt 1" diameter Richmond Insert was checked and found to be 8% over the allowable limit and considered acceptable by the designer. Using the allowable shear values for a 1" diameter insert using A325 bolts from Gibbs & Hill Specification 2323-SS-30, revision 1, Cygna finds that the bolt is overstressed by 13.3%.

Support 3011 is specified to have a width of 100" and a height of 12" using a C6 x 8.2 section for the beam member. This configuration is not within the range qualified by the calculations of reference 1. The original design calculations for the frame specify that maximum height and width to be 99" and 36" respectively for a 24" tray. When the support is loaded with a 30" tray, the support height and width are limited to 42" and 81", respectively. Both analyses assumed a C4 x 7.25 section for the beam member.

Please provide Cygna with justification and documentation for:

(a) The range of heights, widths and tray loadings that the support tray SP-6 is qualified for;

(b) The assumption of a pinned connection for the design of the base connection and anchor bolts;

(c) The use of a shear-tension interaction and eccentricity formulas for anchor bolts which are loaded in shear;

(d) The capability of one-bolt concrete connections which use 1" diameter Richmond Inserts; and

(e) The capability of support 3011 to resist the applied loads.

2. Detail SP-8; Support Number 455
References: (1) Gibbs & Hill Calculation SCS-101C, Set 3
(2) Gibbs & Hill Drawing 2323-S-0903

The design calculations (reference 1) assumed the support to be braced against lateral sidesway by a K-brace configuration. Therefore, it was not necessary to consider the effects of moments due to the lateral motion. The lateral brace was removed by the checker's comments, but no reanalysis to consider the effects of frame sidesway due to transverse loadings was performed.

The frame was analyzed for the effects of vertical loads using moment distribution assuming that the beam-concrete connections were pinned joints. The moment distribution was incorrectly performed since the moments from balancing of the pinned end were not carried-over to the internal joint.

The longitudinal loads were considered to be carried through the beam members to a brace which was attached to the concrete wall. The purpose of the brace was to eliminate weak-axis bending in the beam member. It is Cygna's opinion that weak axis bending as well as torsion of the beam will occur due to the imposition of the longitudinal loads. The attached drawing of the beam and brace as well as an analytical representation of the beam shows the actual eccentricities of the loads.

The stress check for the hangers was based on checking the axial stresses against an allowable of 22 ksi, or 60% of the yield stress. The hanger member has a slenderness ratio (kl/r) of 227 which is an apparent violation of AISC Code section 1.8.4. The brace members are welded all-around to the backs of the beams which provides a moment connection. The braces are also welded to the base angle on one leg only which provides an eccentric load transfer to the base angle. Such moments and eccentric loads were not considered in the design of the brace.

The hanger connections for Detail SP-8 were based on those for Detail SP-3. It is not clear how the hanger connections for Detail SP-3 qualified the connections of an SP-8 since the loads for Detail SP-8 were not clearly determined to make a comparison possible. The connection employing a single Richmond Insert for Detail SP-3 will result in an interaction ratio greater than one when the allowable values from Gibbs & Hill specification 2323-SS-30 are used to check the bolt loads. The design of the hanger connections using Hilti expansion anchors for Detail SP-3 also assumed that a compression force is mobilized in the concrete, thus indicating a moment-resistant connection. Such an assumption is contrary to the original assumption that the hanger-concrete connections are pinned. Allowable eccentricities were also calculated for the hanger connection, but the eccentricity formula does not consider the increase in tensile loads due to prying action.

The brace connection for Detail SP-8 was checked for the design loads of the support. Richmond Inserts used to anchor the brace to concrete were checked for a design load which did not include the accelerated mass of the trays and the support, therefore the load applied to the inserts was too small. Also, the effects of the eccentric loadings from the brace member were not checked. The connection of the brace which employs Hilti expansion anchors did not consider the effect of such eccentric loadings. An allowable eccentricity of the brace location on the base angle is specified, but the calculation of the eccentricity was not shown.

Support 455 was reviewed by Cygna and checked in the field during the walkdowns. The installed support does not contain braces which restrain lateral movement. The braces for the longitudinal loads were moved such that they are located at the centerlines of the hanger members. At this location they provide no load transfer of the longitudinal loads to the concrete through the beam members. Thus, weak-axis bending and torsion must be resisted by the beam members alone.

Please provide Cygna with justification and documentation for:

(a) The capability of generic SP-8 supports to resist the effects due to lateral loads;

(b) The capability of the beam members to resist weak-axis bending and torsional moments;

(c) The use of a member which has a slenderness ratio in opposed violation of AISC Code section 1.8.4;

(d) The capability of the brace members to resist eccentric loads;

(e) The suitability of the Detail SP-3 hanger connections for use on SP-8 supports;

(f) The capability of the anchor bolts used in the brace design to resist the design loads;

(g) The capability of Hilti expansion anchors to resist design loads which are eccentrically applied to the base connection;

(h) The acceptability of the allowed eccentricity for the brace connection; and

(i) The capability of support 455 to resist the applied loads including the effects noted above.

3. Regular Case L-A_4; Support Number 481

References: (1) Gibbs & Hill computer output binder DMI-5P
(2) Gibbs & Hill calculation SCS-101C, Set 2
(3) Gibbs & Hill drawing 2323-S-0902

A representation of a typical Regular Case L-A_4 support is shown on the attached sheet 3A. The analytical model of the support consisted of members CDEFGH, BE and AG. Boundary conditions were assumed as pinned ends for joints A, B, C, E and G. A vertical load was applied in the gravitational direction at node H. A longitudinal load was also applied at node H. Transverse loads were not considered in the analysis.

It is Cygna's opinion that the analytical model as described above is inadequate to correctly predict the behavior of the support under the applied loadings. By considering only a planar frame rather than a space frame, several important loading effects were neglected. The primary effect is the bending moment induced into the beam member HP by vertical loads. These could not be predicted because beam member BE was not modeled and the vertical and longitudinal loads were applied at node B. Reference 3 shows the beam-hanger joints as moment resisting connections. Therefore, vertical and longitudinal loadings within the span of the beam will induce flexural and torsional moments into the hanger members CDEFGH and KLMNOP.

As noted above, the effects from transverse loadings were not considered in the analysis. Thus, axial loads, as well as moments resulting from frame sidesway were neglected in the beam and hanger members.

Brace members CL and DN were not designed because the support was modeled as a planar structure. Brace members AG, BE, IO and JM were not designed for the eccentric application of loads. Such eccentric loadings will induce moments into the angle sections that must be considered in the design.

The original design calculations (reference 2) were not consistent in the application of loads for checking anchor bolts. The anchor bolts were checked for the shear and tension forces due to longitudinal loads only. The effects from both vertical and transverse loads were ignored. In checking the anchor bolts, moments of the applied longitudinal load were taken about node C and a resisting bolt tension was calculated at node A. The moment arm to point A was calculated as L + e rather than L as shown in the attached sketch 3B. The use of the larger moment arm results in a bolt tension 4% smaller than actual.

Based on longitudinal loads only, all anchor bolts exceeded 1.0 in the interaction ratio. To qualify the bolts, and therefore the support, the values of allowable horizontal acceleration, longitudinal tray span or the tray width were calculated. Below any of these levels, the support was considered adequate to resist the applied loads.

Please provide Cygna with justification and documentation for the following:

(a) The capability of Regular Case L-A_4 cable tray supports to resist the design loads. Please discuss the effects due to transverse loads as well as those local effects due to vertical, transverse and longitudinal loadings;

(b) The capability of the bracing members to resist eccentrically applied loadings;

(c) The suitability of using a moment arm to individual bolts rather than the centerline of the base attachment to which they connected; and

(d) The capability of the anchor bolts to resist the design loads.

4. Regular Case L-A_1; Support Number 5807

References: (1) Gibbs & Hill computer output binder DMI-5P
(2) Gibbs & Hill calculation SCS-101C, Set 2
(3) Gibbs & Hill drawing 2323-S-0902

A representation of a typical Regular Case L-A_1 support is shown on the attached sheet. The analytical model of the support consisted of only members AB and BC. Boundary conditions were assumed as pinned ends for joints A, B and C. A vertical load was applied in the gravitational direction at node B. A longitudinal load was also applied at node B. Transverse loads were not considered in the analysis.

It is Cygna's opinion that the analytical model, as described above, is inadequate to correctly predict the behavior of the support under the applied loadings. By considering only a planar frame rather than a space frame, several important loading effects were neglected. In particular, the effects of the vertical and longitudinal bending moments induced into the beam member BE were not considered. These moments could not be predicted because beam member BE was not modeled and the vertical and longitudinal loads were applied at node B. Reference 3 shows the beam-hanger joints as moment resisting connections. Therefore, vertical and longitudinal loadings within the span of the beam BE will induce flexural and torsional moments into the hanger members BC and EF.

As noted above, the effects from transverse loadings were not considered in the analysis. Thus, axial loads as well as moments resulting from sidesway were neglected in the beam and hanger members.

Eccentric loadings of the brace member were not considered in the analysis and design of the frame. Such eccentric loadings will induce moments into the angle section that should be considered in the design.

The original design calculations (reference 2) were not clear in their stress and load checks for support members and anchor bolts. Sheet 3 of reference 2 notes a check for weak axis flexural stresses of the hanger member. It is not clear to Cygna how such moments were calculated since the frame analysis does not consider loadings, in this case transverse, which will induce such moments. This check also noted stresses which exceed allowable levels. A check on beam flexural stresses due to longitudinal loads shows a 5% overstress without consideration of the effects due to vertical and transverse loads. The anchor bolts were checked for longitudinal loads only.

Please provide Cygna with justification and documentation for the following:

(a) The capability of Regular Case $L\text{-}A_1$ cable tray supports to resist the design loads. Please discuss the effects due to transverse loads as well as those local effects due to vertical, transverse and longitudinal loadings;

(b) The capability of the bracing members to resist eccentrically applied loads; and

(c) The capability of the anchor bolts to resist the design loads.

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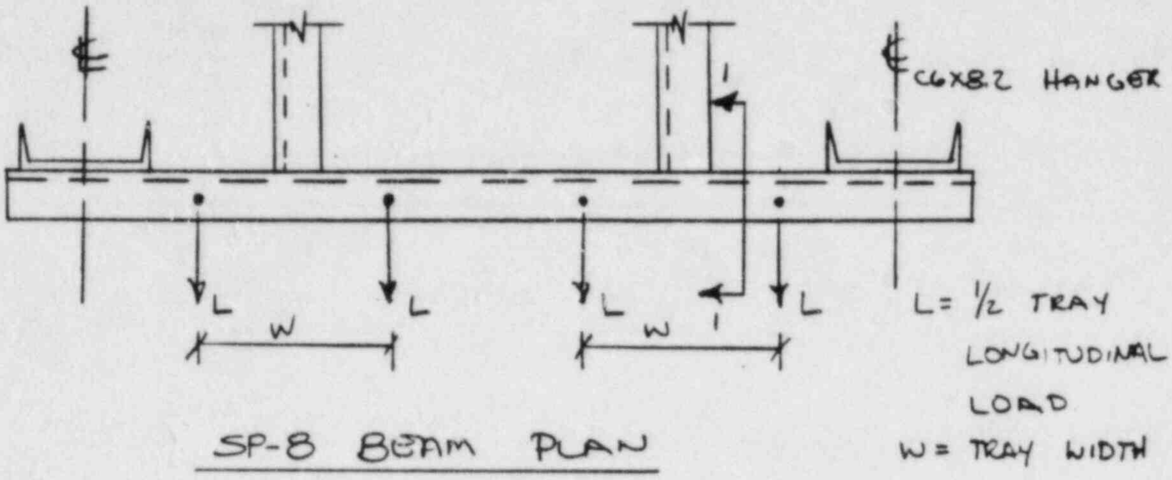
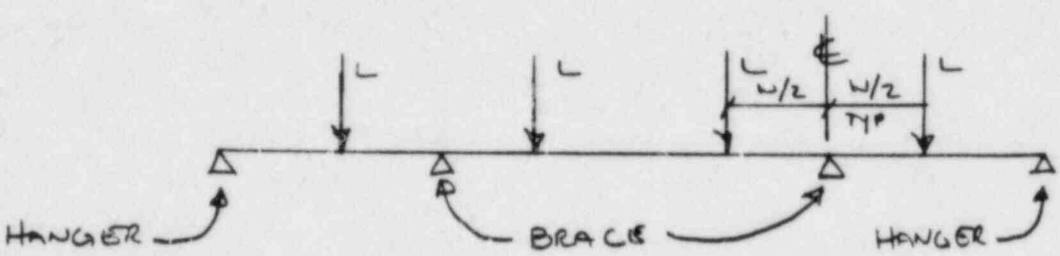
Calculation Sheet

Project: TEXAS UTILITIES - CPSES IAP		Prepared By: J.P.K.	Date: 17 AUG 84
Subject: REVIEW QUESTION 2		Checked By:	Date:
System: DETAIL SP-8		Job No: 84056	File No:
Analysis No:	Rev. No: —	Sheet No:	

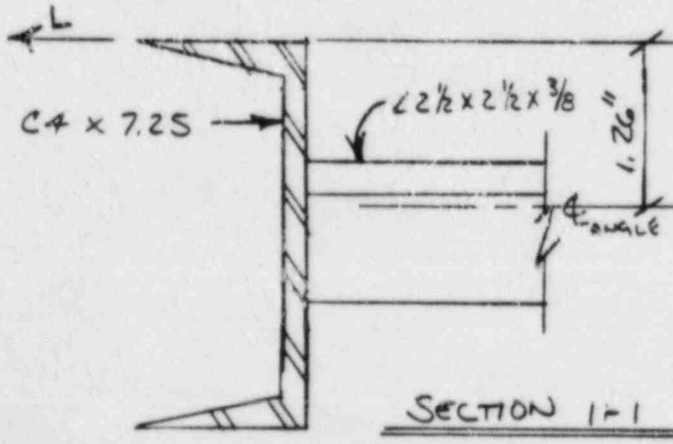


SP-8 BEAM PLAN

(NOT TO SCALE)



ANALYTICAL REPRESENTATION OF SP-8 BEAM FOR WEAK-AXIS BENDING



SECTION 1-1

(NOT TO SCALE)

DRAWING 2A

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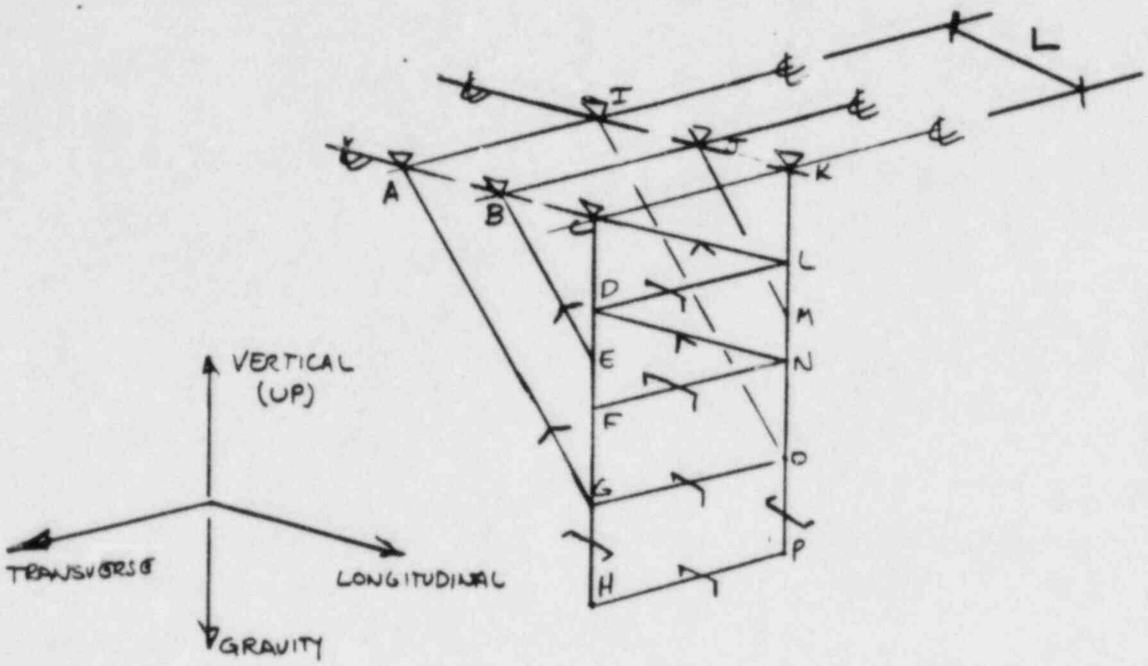
Calculation Sheet

Project: Texas Utilities – CPSES IAP		Prepared By: J.P.R.	Date: 18 Aug 84
Subject: Review Question 3		Checked By:	Date:
System: Regular Case L-A4		Job No: 84056	File No:
Analysis No:	Rev. No: 0	Sheet No:	

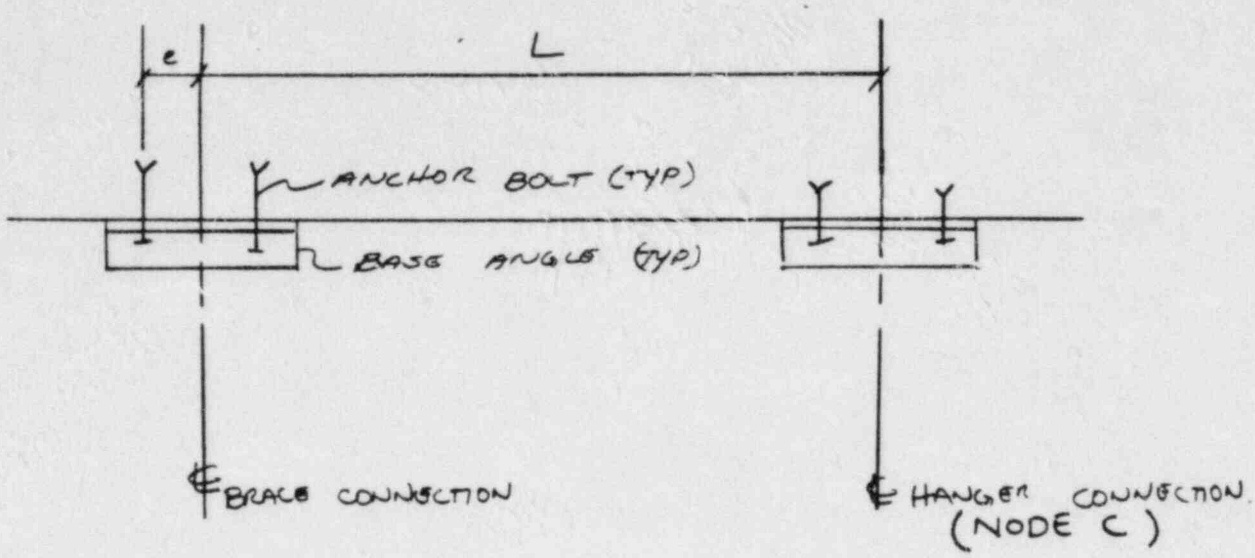


SCHEMATIC REPRESENTATION OF
REGULAR CASE L-A4 SUPPORT

DRAWING 3A

Calculation Sheet

Project: TEXAS UTILITY - CPSES IAP		Prepared By: J.P.R.	Date: 8 AUG 84
Subject: REVIEW QUESTION 3		Checked By:	Date:
System: REGULAR CASE L-A6		Job No: 84056	File No:
Analysis No:	Rev. No: 0	Sheet No:	



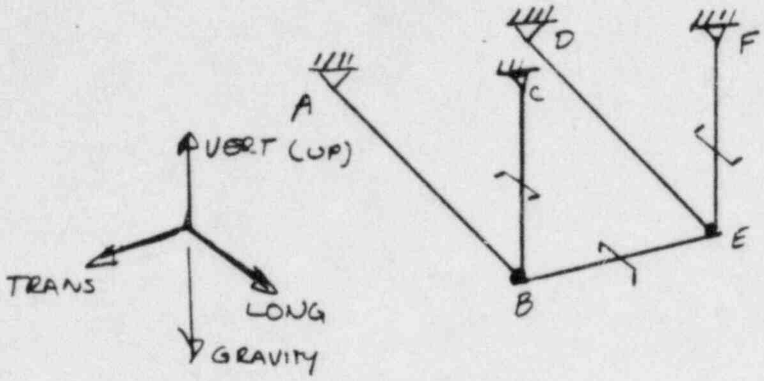
MOMENT ARMS FOR BOLT TENSION CALCULATIONS FOR LONGITUDINAL LOADINGS

DRAWING 3B

CYGNA

Calculation Sheet

Project: TEXAS UTILITIES – CPSES IAP		Prepared By: J. P. R.	Date: 17 AUG '84
Subject: REVIEW QUESTION 4		Checked By:	Date:
System: REGULAR CASE L-A1		Job No: 84056	File No:
Analysis No:	Rev. No: 0	Sheet No:	



SCHEMATIC REPRESENTATION OF
REGULAR CASE L-A1 SUPPORT

DRAWING 4A