CYGNA
ENERGY
SERVICES

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

November 28, 1984
84056.038

Mrs. Juanita Ellis
President, CASE
1426 S. Polk
Dallas, Texas 75224

Subject: Responses to Cygna Questions from the Independent Assessment Program Reviews
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 4
Texas Utilities Generating Company
Job No. 84056

Dear Mrs. Ellis:

Enclosed please find copies of responses to questions from the various disciplines associated with Phase 4 of Cygna's Independent Assessment Program.

Feel free to call if you have any questions or wish to discuss the enclosed documents.

Very truly yours,

D C Oldag

D. C. Oldag
Administrative Assistant

NHW/do
Attachments

cc: Mr. S. Treby (NRC), w/attachments
Mr. S. Burwell (NRC), w/attachments
Mr. D. Wade (TUGCO), w/o attachments
Ms. J. van Amerongen (TUGCO/EBASCO), w/o attachments
Mr. D. Pigott (Orrick, Herrington & Sutcliffe), w/o attachments

2222
1/1

USE ATTACHED DIST.
PER S. BURWELL

CYGNA ENERGY SERVICES

Mrs. Juanita Ellis
84056.038

Attachments

1. R. E. Ballard (G&H) letter to J. B. George (TUGCO), GTN-69484, "Cygna Phase IV Cable Tray Support Review Questions," September 20, 1984.
2. Cygna Communications Report between J. Finneran (TUGCO) and J. Minichiello (Cygna) dated 10/4/84, with handwritten comments and calculations for MS-1-1-5-S72R and MS-1-2-5-S72R attached.
3. D. H. Wade (TUGCO) letter to N. H. Williams (Cygna), CPPA-41237, "Response to Cygna Questions," October 3, 1984.
4. L. M. Popplewell (TUGCO) letter to N. H. Williams (Cygna), "Cygna Review Questions, Reference Cygna letter 84056.023 dated August 21, 1984, Question 1," October 1, 1984.
5. TUGCO response to Cygna Question 5 from letter 84056.022, dated August 17, 1984.
6. L. M. Popplewell (TUGCO) letter to N.H. Williams (Cygna), "Cygna Review Questions, Reference Cygna letter 84056.023 dated August 21, 1984, Question 3," September 25, 1984.
7. L. M. Popplewell (TUGCO) letter to N.H. Willliams (Cygna), "Cygna Review Questions, Reference Cygna letter 84056.031 dated August 31, 1984, Question 2," September 28, 1984.

Gibbs & Hill, Inc.

11 Penn Plaza
New York, New York 10001
212 760- 4438
Telex:
Domestic: 127636/968694
International: 428813/234475

A Dravo Company

GTN-69484

September 20, 1984

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George
Vice President/Project Gen. Manager

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
G&H PROJECT NO. 2323
CYGNA PHASE IV CABLE TRAY SUPPORT REVIEW QUESTIONS
REF: CYGNA LTR 84056.031 DTD. 8-6-84

By copy of this letter to Nancy Williams of CYGNA, attached please find the following calculations in response to CYGNA Phase IV review question transmitted via the above reference:

SCS-101C, Set 3, Rev. 8

Responses to remaining questions will follow.

Very truly yours,

GIBBS & HILL, INC.

R. E. Ballard

Robert E. Ballard, Jr.
Director of Projects

REBa-ELB-AMK:sce
1 Letter

cc: ARMS (B&R Site) OL
N. Williams (CYGNA CA) 1L, 1A
J. Van Amerongen (CPPE Site) 1L, 1A
D. Wade (TUSI Site) 1L, 1A
C.R. Hooton (TUSI Site) 1L, 1A
→ J. Russ (CYGNA CA) 1L, 1A (hand carried)

CYGNA 103

JOB NO: 84056
DATE REC'D/LOGGED: 11/12/84
LOG NO.: #42
FILE: 2.1.1 Inc. Corr. [illegible]
CROSS REF. FILE 11.1.1 Tech Files #204

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS — RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 222

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-7-84						
Checker			NV	9.14.84						

QUESTION 1: CYGNA LETTER 84056.031 ATTACHMENT A item 1

CABLE TRAY SUPPORT NUMBER 202

PURPOSE OF CALCULATION: TO PROVIDE JUSTIFICATION FOR THE ADEQUACY OF CABLE TRAY SUPPORT # 202 (TYPE A4)

REFERENCES:

1) LETTER 84056.031 FROM CYGNA TO MR. J. B. GEORGE DATED AUG. 31, 1984, ATTACHMENT A, ITEM 1

2) SCS-101C SET 3

3) G & H. DWG'S a) 2323-E1-0700-01-S REV. 3

b) 2323-S-0901 REV. 4

c) 2323-S-0903 REV. 5

d) 2323-S-0902 REV. 5

4) SCS-137C SET 2

CYGNA
JOB NO.: 84056
DATE REC'D/LOGGED: 11/12/84
DOC I.D.: # 244
FILE: 11.1.1 Tech. Files
CROSS REF. FILE: A.1.1 Inc. Cr (# 42)

JUSTIFICATION:

THE ADEQUACY OF SUP'T # 202 (TYPE A4, MODIFIED PER CMC 4552 R2) to support VERTICAL AND TRANSVERSE LOADS IS SHOWN ON SH. 4 R.0 OF REF. 4. LONGITUDINAL LOAD (45° TO E-W DIRECTION) IS RESISTED BY SUPPORT # 455 (SP-8), A SUP'T THAT CAN RESIST LONGITUDINAL LOAD IN E-W DIRECTION AND LOCATED AT APPROXIMATE 7'-0" S.W. OF SUPPORT # 202. THE FOLLOWING CALCULATION DEMONSTRATES THE ADEQUACY OF SUP'T SP-8 AND THE TRAY SEGMENTS.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Comparison of computer with corresponding inputs and results of similar codes

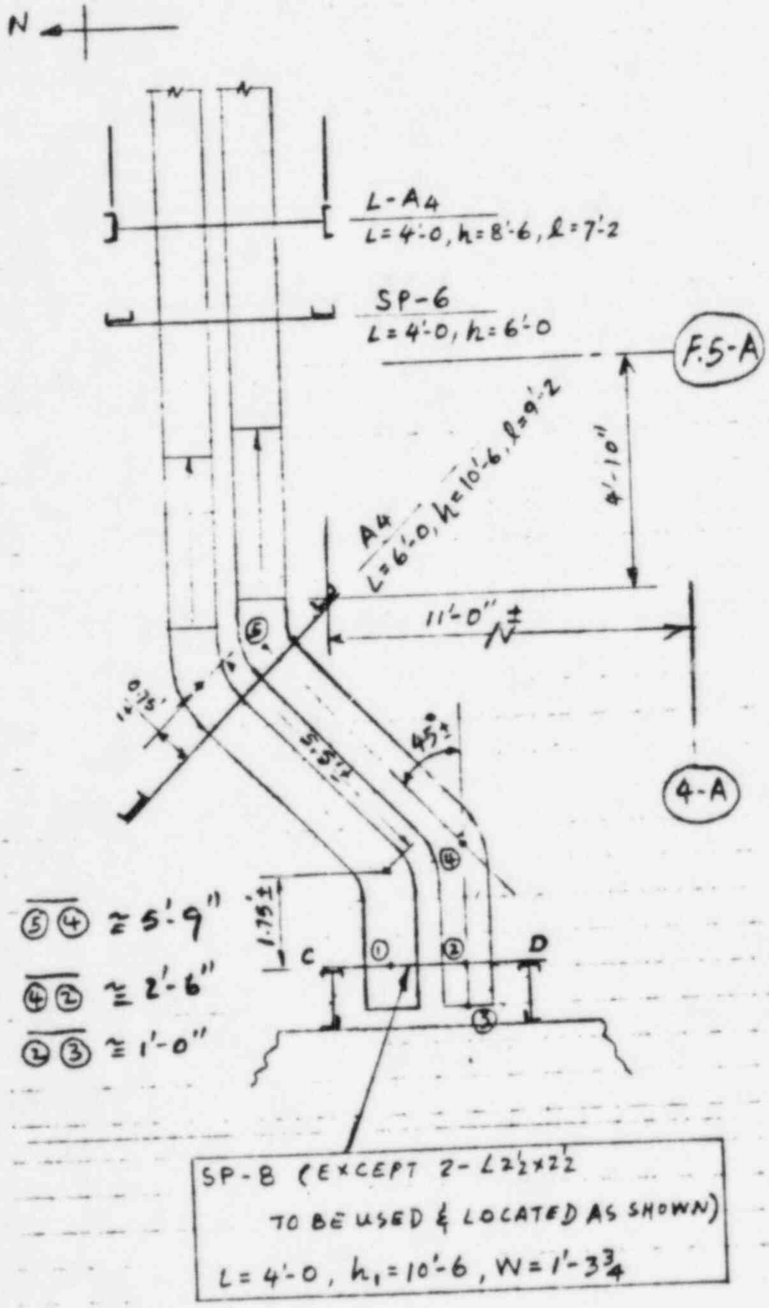
F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 223

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			MC	9-7-84						
Checker			NV	9.14.84						



AUX. BLDG. EL 810'-6

REFINED 'g' VALUES
(REF. SCS-101C SET 5 SH 19 R.2)

½SSE; $g_v = 1.48$ $g_H = 0.71$

SSE; $g_v = 2.31$ $g_H = 1.03$

$$\frac{G_V(SSE)}{G_V(\frac{1}{2}SSE)} = \frac{2.31+1}{1.48+1} = 1.33$$

$$\frac{G_H(SSE)}{G_H(\frac{1}{2}SSE)} = \frac{1.03}{0.71} = 1.45$$

PLAN FL. ELEV. 790'-6"
(REF. 3a)

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject: CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number: SCS-101C SET 3		Sheet No. 224

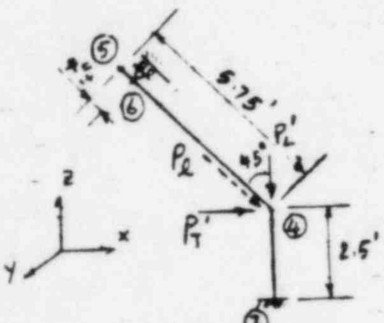
	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Revision										
Checking Method #			1							
Preparer			MC	9-8-84						
Checker			NV	9.14.84						

CHECK TRAY
CRITICAL @ '②'

12" TRAY - GG-12-SC-12-06 ⇒ $F_n = 265$ #/, $F_t = 424$ #/, $F_\ell = 1295$ #/, } VENDOR INFORMATION

SSE CONDITION:

DUE TO LONGIT'L LD.



PLAN

$$P_\ell = 35 \times 1 \times 5.75' \times 1.03 = 208^{\#}$$

$$P_L' = 208 \sin 45^\circ = 147^{\#} = P_T'$$

$$R^L_{z②} = 147 + 35 \times 1 \times 2.5 \times 1.03 = 238^{\#}$$

DUE TO TRANSV. LD — ASSUME PINNED @ '⑥' & FIXED @ '②' (CONSERVATIVE FOR CHECKING TRAY ONLY)

$$R_{x②} \cong \frac{5}{8} \times (35 \times 1 \times 1.03) \times 7.92 \;(5.42+2.5) + 147^{\#}(P_T')^{*} = 326^{\#}$$

$$M^T_{y②} \cong \frac{1}{8} \times (35 \times 1 \times 1.03) \times 7.92^2 + 147 \times 2.5^{*} = 650'^{-\#}$$

* ADD'L DUE TO P_ℓ (CONSERVATIVE)

DUE TO VERT. LD — MOM. DUE TO OVERHANG $\overline{②③}$, $M_x^{DL} = \frac{1}{2} \times (35 \times 1) \times 1.0^2 = 18'^{-\#}$

$$M_x^V = 2.31 \times 18 = 42'^{-\#}$$

INTERACTION: $1.6\left[\frac{f_n'}{F_n} + \sqrt{\left(\frac{f_n}{F_n}\right)^2 + \left(\frac{f_t}{F_t}\right)^2 + \left(\frac{f_\ell}{F_\ell}\right)^2}\right] \le 1$

$$1.6\left[\frac{18}{8 \times 265} + \sqrt{\left(\frac{42}{8 \times 265}\right)^2 + \left(\frac{650}{8 \times 424}\right)^2 + \left(\frac{238}{8 \times 1295}\right)^2}\right]$$

$$= 1.6\left[0.0085 + \sqrt{0.0198^2 + 0.1916^2 + 0.0230^2}\right] = 0.324 < 1.0$$

TRAY IS O.K.

HEAVY DUTY TRAY CLAMP @ '②' (REF. 3d) THE ABOVE REACTIONS ARE VERY SMALL, AND OVERHANG $\overline{②③}$ IS ONLY 1.0 FT., NO CALCULATION REQ'D. TRAY CLAMP IS O.K.

Checking Method #
1 Line by line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 225

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			WC	9-10-84							
Checker			NV	9.14.84							

CHECK SUPPORT # 455 (SP-8) ½ SSE CONDITION

REF. SHT'S 217 TO 221 R.7 OF REF. 2

@ PT. ①

VERT. LD. $P_{y1}^{DL} = 0.04 \times 1' \times \left\{ \frac{1}{2}(4.75 + 1.75) + 1.0 \right\} = 0.130 + 0.04 = 0.17^{K}$

LONGIT. LD. $P_{z1}^{L} = (0.04 \times 1' \times 5.5' \times 0.71) \times \sin 45^{\circ} + 0.04 \times 1 \times (1.75 + 1.0) \times 0.71$

$= 0.110 + 0.078 = 0.189^{K}$

TRANSV LD $P_{x1}^{T} = (0.04 \times 1' \times 5.5' \times 0.71) \times \sin 45^{\circ} + (0.130 + 0.04) \times 0.71$

$= 0.110 + 0.092 + 0.028 = 0.23^{K}$

$M_{y1}^{T} = 0.110 \times 1.75 - 0.028 \times \frac{1.0}{2} = 0.179^{1\text{-}K} = 2.142^{4\text{-}K}$

@ PT. ②

VERT. LD. $P_{y2}^{DL} = 0.04 \times 1' \times \left\{ \frac{1}{2}(5.42 + 2.5) + 1.0 \right\}$

$= 0.158 + 0.040 = 0.198^{K}$

LONGIT. LD. $P_{z2}^{L} = (0.04 \times 1 \times 5.75 \times 0.71) \times \sin 45 + 0.04 \times 1 \times (2.5 + 1.0) \times 0.71$

$= 0.115 + 0.099 = 0.214^{K}$

TRANSV. LD. $P_{x2}^{T} = (0.04 \times 1 \times 5.75 \times 0.71) \times \sin 45 + (0.158 + 0.04) \times 0.7)$

$= 0.115 + 0.112 + 0.028 = 0.255^{K}$

$M_{y2}^{T} = 0.115 \times 2.5 - 0.028 \times \frac{1.0}{2} = 0.274^{1\text{-}K} = 3.282^{11\text{-}K}$

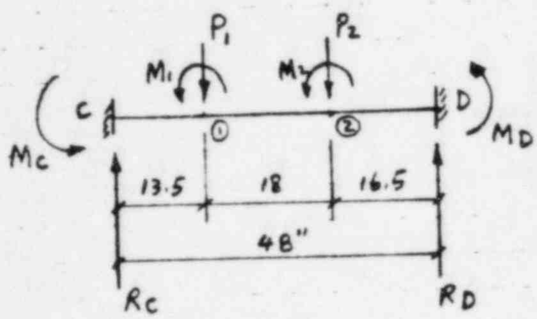
Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

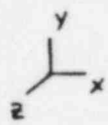
Calculation Number SCS-101C SET 3 Sheet No. 226

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-10-84						
Checker			NV	9.14.84						



FOR REACTIONS; REFER TO "ANALYSIS OF FRAMED STRUCTURES" BY GERE AND WEAVER © 1965 PAGE 453.

DUE TO VERT. LD



$$M^{DL}_{ZC} = \frac{0.17 \times 13.5 \times 34.5^2}{48^2} + \frac{0.198 \times 31.5 \times 16.5^2}{48^2}$$

$$= 1.186 + 0.737 = 1.923^{\text{''-K}}$$

$$M^{DL}_{ZD} = -\frac{0.17 \times 13.5^2 \times 34.5}{48^2} - \frac{0.198 \times 31.5^2 \times 16.5}{48^2}$$

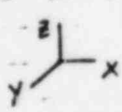
$$= -0.464 - 1.407 = -1.871^{\text{''-K}}$$

$$R^{DL}_{YC} = \frac{0.17 \times 34.5^2}{48^3}(3 \times 13.5 + 34.5) + \frac{0.198 \times 16.5^2}{48^3}(3 \times 31.5 + 16.5)$$

$$= 0.137 + 0.054 = 0.191^K$$

$$R^{DL}_{YD} = 0.17 + 0.198 - 0.191 = 0.177^K$$

DUE TO LONGIT. LD.



$$M^L_{YC} = \frac{0.189}{0.17} \times 1.186 + \frac{0.214}{0.198} \times 0.737 = 1.319 + 0.797 = 2.116^{\text{''-K}}$$

$$M^L_{YD} = \text{"} \times (-0.464) + \text{"} \times (-1.407) = -0.516 - 1.521 = -2.037^{\text{''}}$$

$$R^L_{ZC} = \text{"} \times 0.137 + \text{"} \times 0.054 = 0.152 + 0.058 = 0.21^K$$

$$R^L_{ZD} = 0.189 + 0.214 - 0.21 = 0.193^K$$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

6

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 227

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-10-84						
Checker			NV	9.14.84						

DUE TO TRANSV. LD. $R^T_{xC} \cong R^T_{xD} \cong \frac{1}{2} \times (0.23 + 0.255) = 0.243^K$

$$M^T_{yC} = -\frac{2.142 \times 34.5}{48^2}(2\times13.5-34.5) - \frac{3.282\times16.5}{48^2}(2\times31.5-16.5)$$

$$= 0.241 - 1.093 = -0.852^{\text{"-K}}$$

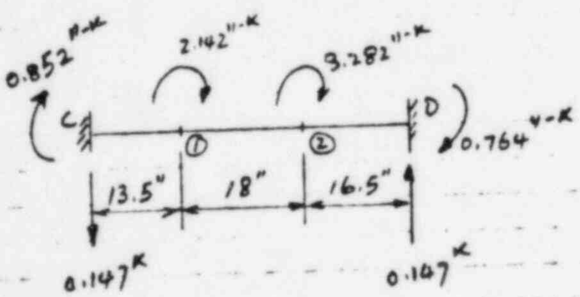
$$M^T_{yD} = -\frac{2.142\times13.5}{48^2}(2\times34.5-13.5) - \frac{3.282\times31.5}{48^2}(2\times16.5-31.5)$$

$$= -0.697 - 0.067 = -0.764^{\text{"-K}}$$

$$R^T_{zC} = -\frac{6\times2.142\times13.5\times34.5}{48^3} - \frac{6\times3.282\times31.5\times16.5}{48^3}$$

$$= -0.054 - 0.093 = -0.147^K$$

$$R^T_{zD} = 0.147^K$$

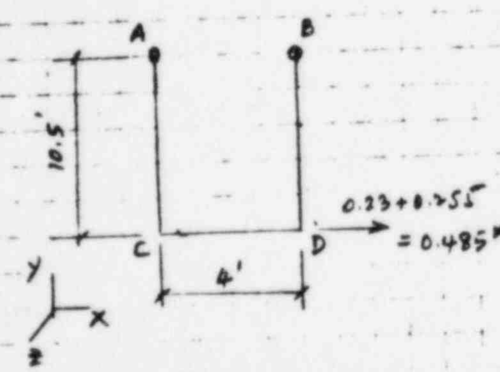


$M^T_{y①} = 0.852 - 0.147\times13.5 = -1.133^{\text{"-K}}$ (+1.009)

$M^T_{y②} = 0.147\times16.5 - 0.764 = 1.662^{\text{"-K}}$ (-1.620)

BEAM C4x7.25: $f^T_{by@C} = \frac{0.852}{0.343} = 2.484^{KSI}$

$f^T_{by@②} = \frac{1.662}{0.343} = 4.845^{KSI}$



$M^T_{zC} = M^T_{zD} = \frac{0.485}{2}\times10.5\times12 = 30.555^{\text{"-K}}$

$R_{yC} = R_{yD} = \frac{0.485\times10.5}{4.0} = 1.273^K$

$f^T_{bz} @ C = \frac{30.555}{2.29} = 13.343^{KSI}$

$f^T_{bz} @ ② = \frac{24-16.5}{24}\times13.343 = 4.170^{KSI}$

@ C; $f^T_b = 2.484 + 13.343 = 15.827^{KSI} > 4.845 + 4.170 = 9.015^{KSI}$ @ ②

∴ PT. 'C' IS CRITICAL

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

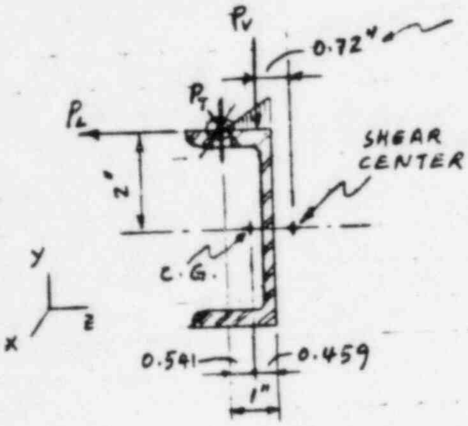
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 228

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-11-84						
Checker			NV	9.14.84						

CHECK BEAM C4X7.25 OF SUP'T # 455

SEE SCS-111C SET B SH. 28 R. 1



C4x7.25

DUE TO ECCENTRICITY

VERT. LD;

$M^{DL}_{X1} = 0.17 \times 0.72 = 0.122$ "-K

$M^{DL}_{X2} = 0.198 \times 0.72 = 0.143$ "-K

LONGIT. LD;

$M^{L}_{X1} = 0.189 \times 2 = 0.378$ "-K

$M^{L}_{X2} = 0.214 \times 2 = 0.428$ "-K

TRANSV. LD;

$M^{T}_{Y1} = 0.23 \times 0.541 = 0.124$ "-K

$M^{T}_{Y2} = 0.255 \times 0.541 = 0.138$ "-K

$M^{T}_{Z1} = 0.23 \times 2 = 0.46$ "-K

$M^{T}_{Z2} = 0.255 \times 2 = 0.51$ "-K

$\Delta M^{T}_{YC} = \frac{0.124}{2.142} \times 0.241 - \frac{0.138}{3.282} \times 1.093 = 0.014 - 0.046 = -0.032$ "-K

$\Delta M^{T}_{YD} =$ " $\times (-0.697) -$ " $\times 0.067 = -0.040 - 0.003 = -0.043$ "-K

$\Delta R^{T}_{ZC} =$ " $\times (-0.054) -$ " $\times 0.093 = -0.003 - 0.004 = -0.007$ K

$\Delta R^{T}_{ZD} = 0.007$ K

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS — RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 229

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			WC	9-11-84							
Checker			NV	9.14.84							

DUE TO ECCENTRICITY, TRANSV LD (CONT'D)

$$\Delta M^T_{ZC} = \frac{2.0''}{0.541''} \times (-0.032) = -0.118^{\text{''-K}}$$

$$\Delta M^T_{ZD} = \text{''} \times (-0.043) = -0.159^{\text{''-K}}$$

$$\Delta R^T_{YC} = \text{''} \times (-0.007) = -0.026^{K} = -\Delta R^T_{YD}$$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 230

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-11-84						
Checker			NV	9.14.84						

CHECK BEAM C4x7.25 OF SUP'T #455 REF. 2 SHT'S 218 & 219 R.7

SECTION @ 'C':

$$\phi''_c = \frac{0.67 M_{①} + 0.26 M_{②}}{11.2\times10^3 \times 0.082 \times 6.25} = 0.17422\times10^{-3}(0.67 M_{①} + 0.26 M_{②})$$

$$\sigma_{no} = 29\times10^3 \times 1.88 \times 0.17422\times10^{-3}(0.67 M_{①} + 0.26 M_{②})$$

$$= 9.5\,(0.67 M_{①} + 0.26 M_{②})$$

VERT. LD. $f_{bz}^{DL} = \frac{1.923}{2.29} = 0.840^{KSI}$ $f_{bz}^{V} = 0.840\times1.48 = 1.243^{KSI}$

$\sigma_{no}^{DL} = 9.5(0.67\times0.122 + 0.26\times0.143) = 1.130^{KSI}$ $\sigma_{no}^{V} = 1.13\times1.48 = 1.672^{KSI}$

LONGIT. LD. $f_{by}^{L} = \frac{2.116}{0.343} = 6.169^{KSI}$

$\sigma_{no}^{L} = 9.5(0.67\times0.378 + 0.26\times0.428) = 3.463^{KSI}$

TRANSV. LD. $f_a^{T} = \frac{0.243}{2.13} = 0.114^{KSI}$ $\frac{f_a^T}{F_a} = \frac{0.114}{12.07} = 0.009 < 0.15$

$f_{by}^{T} = \frac{0.852 + 0.032}{0.343} = 2.577^{KSI}$

$f_{bz}^{T} = \frac{30.555 + 0.118}{2.29} = 13.394^{KSI}$

INTERACTION:

$$\left(\frac{0.840+1.130}{22}\right)_{DL} + \left[\left(\frac{1.243+1.672}{22}\right)^2 + \left(\frac{6.169+3.463}{22}\right)^2 + \left(0.009 + \frac{2.577+13.394}{22}\right)^2\right]^{\frac{1}{2}}_{EQ}$$

$$= 0.090 + \left[0.133^2 + 0.438^2 + 0.735^2\right]^{\frac{1}{2}} = 0.956 < 1.0$$

BEAM C4x7.25 IS ADEQUATE

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 231

Revision	Original Issue	Date	Rev. 8	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-11-84						
Checker			NV	9.14.84						

CHECK SUPPORT #455 (SP-8)

BEAM C4 x 7.25 IS THE MOST CRITICAL ITEM THAT CONTROLS THE CAPACITY OF SUP'T #455 (SHT'S 217 TO 221 R.7 OF REF. 2). SINCE BEAM IS ADEQUATE, NO FURTHER CALCULATION IS REQ'D. SUP'T #455 IS ADEQUATE.

CONCLUSSION:

THE AFFECTED CABLE TRAY SEGMENTS ARE ADEQUATELY SUPPORTED WITHOUT OVERSTRESSING THE TRAYS. TRANSVERSE AND VERTICAL LOADS ARE SUPPORTED BY SUP'T #202 & #455 WHILE LONGITUDINAL LOAD IS SUPPORTED BY SUP'T #455.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Report

Company: Texas Utilities ☒ Telecon ☐ Conference Report

Project: Comanche Peak Steam Electric Station Independent Assessment Program - Phase 4

Job No. 84056

Date: 10/4/84

Subject: Support MS-1-002-005-S72R Local Buckling and Bending Stresses MS-1-001-005-S72R

Time: 10:30

Place: SF

Participants	of
J. Finneran	TUGCO
J. Minichiello	Cygna

CYGNA	
JOB NO :	84056
DATE REC'D/LOGGED:	10/18/84
LOG NO.:	# 37
FILE:	2.1.1 Inc. CR
CROSS REF. FILE	2.1 Inc. CR Log

Item	Comments	Required Action By
	As stated in the telecon between J. Finneran and N. Williams, Cygna ran a finite element model of the tubesteel/ coverplate (items 2 and 3 of drawing) to determine the effects of warpage on tubesteel stresses. Cygna's evaluation showed that the warpage does not impact the design adequacy of the tubesteel. Cygna had not found any thickness sizing calculations for the cover plate. Cygna requested TUGCO perform calculations to show the thickness is adequate for localized bending in the region of the u-bolt holes. Cygna's finite element results have shown high bending stresses in the area of the cover plate near the hole. These finite element stresses consist of both peak and average effects. A sizing calculation for the thickness, done in accordance with appropriate standards, will be needed. Mr. Finneran will provide these calculations.	JF (TUGCO)

We have applied the AWS local stress evaluation from AWS D1.1-79, Section 10 to MS1-002-005-S72R and MS1-001-005-S72R. The calculations are attached. As can be seen the stress ratios are very low. Even assuming that ~~half the material~~ the stresses would be double the calculated stresses would still lead to an acceptable stress situation.

Rec'd from J. Finneran TUGCO Calc. for MS-1-1-S-S72R

Signed: N H Williams /dwm Page 1 of 1

Distribution: N. Williams, D. Wade, J. Van Amerongen, J. Minichiello, S. Treby, J. Ellis, T. Purcell, Project File

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

CYGNA

Date 10 OCT 84

Calc By GMC

Chk'd/Apprd. By [initials] 10/11/84

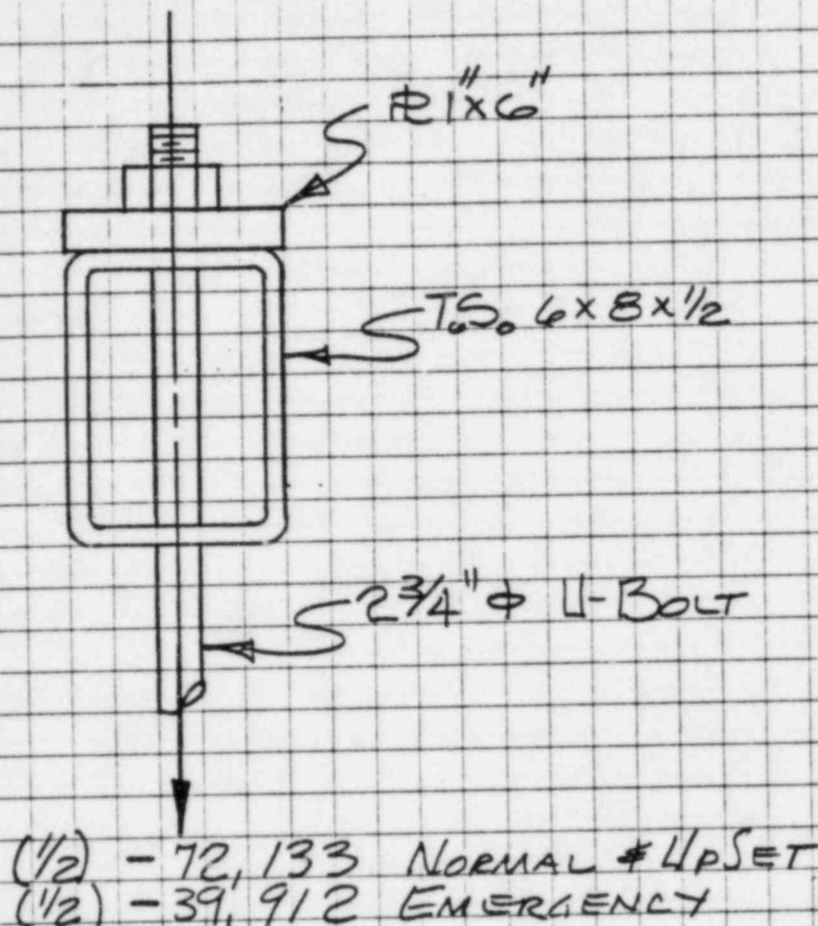
Subject MS-1-001-005-S72R Rev. 6

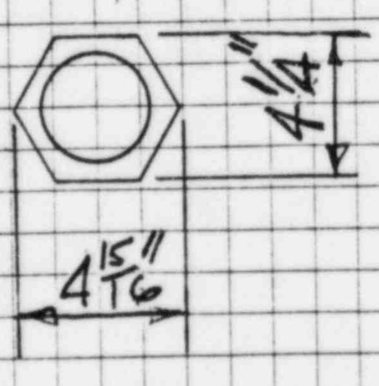
Filing Code 84056

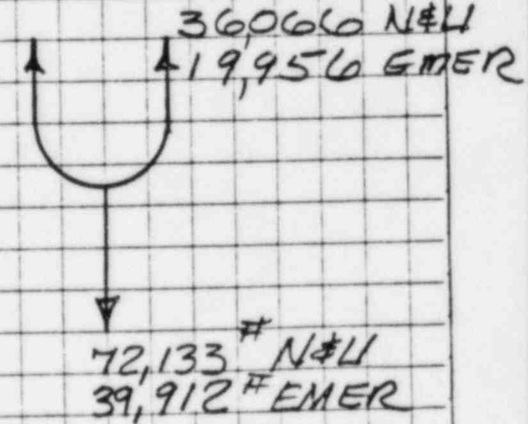
Sheet No. 1 Of 3

G & H Job. No.

Ref. Dwg./Spec. No.







FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 10 OCT 84
Calc By GMC
Chk'd/Apprd. By [initials] 10/12/84
Subject MS-1-001-005-S72R Rev. 6 Ref. Dwg./Spec. No.

Filing Code CYGNA 84056
Sheet No. 2 of 3
G & H Job. No.

1.) ACTING PUNCHING SHEAR — AISC 4-137 8TH ED

USE THE COLLAR DIAMETER, 4¼", THIS IS A VERY CONSERVATIVE ASSUMPTION

PERIMETER IS $(4\frac{1}{4}'')(\pi) = 13.35$ IN.

PUNCH'G SHEAR IN LBS/LINEAR INCH

$36066^{\#}/13.35 = 2702$ #/LINEAR INCH IN N&U

PUNCHING SHEAR IN PSI

$$\frac{2702\ \#/IN}{THICKNESS} = \frac{2702}{(\frac{1}{2}+1)} = 1801\ PSI$$

∴ ACT'G PUNCHING SHEAR = 1801 PSI

2) ALLOWABLE PUNCHING SHEAR — AWS D1.1-79 10.3 THRU 10.6

$$V_P = Q_B Q_f \left[\frac{F_y}{0.6\left(\frac{D}{2t}\right)} \right]$$

WHERE:

$$Q_\beta = 1.21 = \frac{0.25}{\left(\frac{4.25}{6}\right)\left(1-\frac{4.25}{6}\right)}$$

$Q_f = 1$ WHEN $U \leq 0.44$ $\quad U = \frac{f_a + f_b}{0.6 F_y}$

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 10 Oct 84
Calc By GMC
Chk'd/Apprd. By [signature] 10/11/84
Subject MS-1-001-005-S72R Rev 6 Ref. Dwg./Spec. No.

CYGNA
Filing Code 84056

G & H Job. No.

2 CONTINUED)

F_y = 31.9 KSI @ 300° FOR A-36
37.2 KSI @ 300° FOR A-500

D = 6 INCHES

t = TUBE STEEL THK + PLATE THICK
OR (1 + .5) = 1.5 INCH

$$\therefore V_p = (1.21)(1.0)\left[\frac{31.9}{0.6\left(\frac{6}{2(1.5)}\right)}\right] = 32.17$$

& Vp CANNOT EXCEED (.4) F_y

∴ Vp ALLOWABLE IS (.4)(31.9) = 12.76 KSI

3.) COMPARE ACTING Vp WITH ALLOW. Vp

$$\frac{1801 \text{ PSI}}{12760 \text{ PSI}} = .1411 = 14\%$$

OF ALLOWABLE

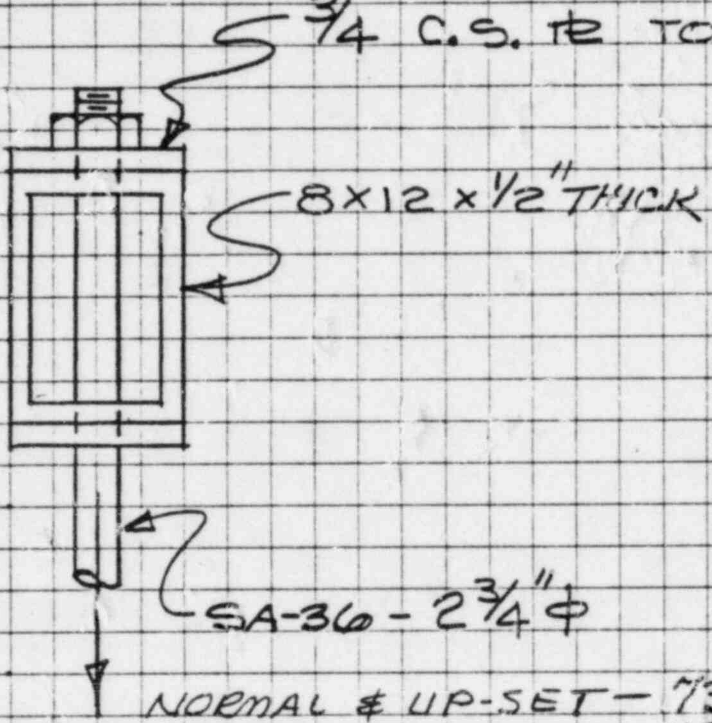
– N&U CONTROLS –

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

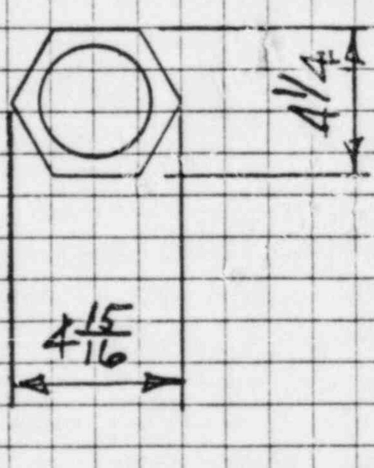
Date 10 Oct 84
Calc By GMC
Chk'd/Apprd. By NAB 10/11/84
Subject MS-1-002-005-S72R Rev 6 Ref. Dwg./Spec. No. —

CYGNA
Filing Code 84056 10/4/84
Sheet No. 1 Of 4
G & H Job. No.



NORMAL & UP-SET - 73887
EMERGENCY - 42,973

N&U LOAD CONTROLS



FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

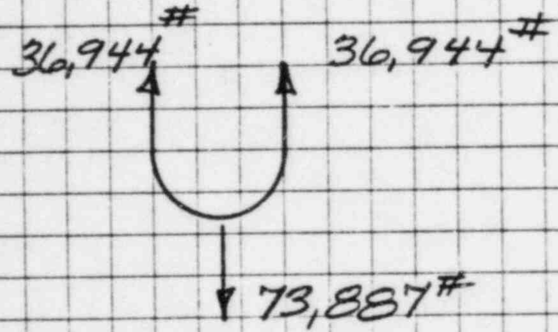
Date 10 OCT 84
Calc By GMC
Chk'd/Apprd. By NFB 10/11/84
Subject MS-1-002-005-S72R Rev 6
Ref. Dwg./Spec. No.

CYGNA
Filing Code 84056
Sheet No. 2 Of 4
C & H Job. No.

1.) ACTING PUNCHING SHEAR, V_{P_A}.

USE COLLAR DIAMETER OF 4.25" INCH - USING THE COLLAR DIAMETER IS VERY CONSERVATIVE — AISC 4-137 8TH ED

PERIMETER IS $(4.25)(\pi) = 13.35$ IN



PUNCHING SHEAR IN #/LINEAR INCH

$36{,}944^{\#}/13.35 = 2767^{\#}/\text{IN}$

$$\frac{2767^{\#}/\text{IN}}{\text{THICKNESS}} = \frac{2767^{\#}/\text{IN}}{(1/2'' + 3/4'')} = 2214 \text{ PSI}$$

∴ ACTING PUNCHING SHEAR = 2214 PSI

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

CYGNA

Date 10 OCT 84
Calc By GMC
Chk'd/Apprd. By [illegible] 10/11/84
Subject MS-1-002-005-S72R REV 6

Filing Code 84056

G & H Job. No.
Ref. Dwg./Spec. No.

2) FIND ALLOWABLE, V_p.

$$V_p = Q_\beta Q_f \times \left[F_y / 0.6 \left[\frac{D}{2t} \right] \right]$$

$$Q_\beta = \frac{0.25}{\beta(1-\beta)} = \frac{0.25}{\left(\frac{4.25}{8}\right)\left(1 - \frac{4.25}{8}\right)} = 1.003922$$

$Q_f = 1.00$ IF MAIN MEMBER IS STRESSED 44% OR LESS

F_y = 31.9 KSI @ 300° FOR A-36
37.2 KSI @ 300° FOR A-500

USE 31.9 - CONSERVATIVE

D = 8 INCH

t = 1/2 + 3/4 = 1.25 INCH

$$\therefore V_p = (1.003922)(1.00)\left[\frac{31.9}{(0.6)\left(\frac{8}{2(1.25)}\right)}\right] = 16.6797 \text{ KSI}$$

V_p = 16.68 KSI

CANNOT EXCEED (.4) F_y

AWS D1.1-79
10.3 THRU 10.6

$\therefore V_p$ = 12.76 KSI

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 10 Oct 84

Calc By GMC

Chk'd/Apprd. By MB 10/11/84

Subject MS-1-002-005-S72R Rev 6

Ref. Dwg./Spec. No.

CYGNA

Filing Code 84056

Sheet No. 4 of 4

G & H Job. No.

3.) COMPARE ACTING V_p WITH ALLOWABLE V_p

$$\frac{V_{p\,ACT'G}}{V_{p\,ALLOWABLE}} = \frac{2214\,psi}{12760\,psi} = .1735$$

≈ 17% OF ALLOWABLE – N&U CONTROLS

8405G PF

CPPA - 41237

TEXAS UTILITIES GENERATING COMPANY

P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

PROJECT FILE

October 3, 1984

NOTED OCT 09 1984 N.WILLIAMS

CYGNA Energy Services
101 California Street
Suite 1000
San Francisco, CA 94111

Subject: COMANCHE PEAK STEAM ELECTRIC STATION FOLLOW-UP RESPONSE TO CYGNA QUESTIONS

Dear Ms. Williams:

Pursuant to an October 1, 1984 conference call with CYGNA's Ms. N. Williams and Mr. R. Hess, TUGCO is providing further clarification to question number 4 of letter 84056.010.

The July 23, 1984 Westinghouse letter identifying the potential for overpressurization of the Component Cooling Water System states that, "Typically the limiting condition is the rupture of a tube in the reactor coolant pump barrier". TUGCO has filed a potential 50.55(e) on this problem and is pursuing its resolution . In addition, TUGCO is evaluating potential ruptures in the letdown heat exchanger and in the Residual Heat Removal heat exchanger.

Due to TUGCO's conservative approach on this issue and our obligation to resolve such issues to the satisfaction of the NRC, CYGNA should dispose of this issue as discussed.

Sincerely,

David H. Wade

David. H. Wade
Project Manager

DHW/bh

cc: ARMS
J.B. George
J. Van Amerongen
F.W. Madden
L.M. Popplewell

CYGNA	
JOB NO.:	84056
DATE LOGGED:	10/9/84
LOG NO.:	11 36
FILE:	2.1.1 Inc. Cr.
CROSS REF. FILE	2.1 Inc. Cr. Log

Distribution:
R. Hess
J.P. Foley
P. Rainey
N. Williams

84056/PF

Recd. 10/2/84 NHW

TEXAS UTILITIES GENERATING COMPANY

P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

Distribution
R. Hess
N. Williams
J. P. Foley
P. Rainey
84056 PF

October 1, 1984

Cygna Energy Services
101 California Street
Suite 1000
San Francisco, California 94111

Attn: Ms. Nancy Williams, Project Manager

COMANCHE PEAK STEAM ELECTRIC STATION
CYGNA REVIEW QUESTIONS

REF: 1) CYGNA LETTER 84056.023 DATED August 21, 1984

Dear Ms. Williams:

Attached is TUGCO's response to the following:

1. Question 1 Reference 1

This revised response supercedes the previously transmitted response. If there are any further questions or comments, please contact Ms. Jeanne J. Van Amerongen (Extension 500).

Very truly yours,

L M Popplewell

L. M. Popplewell
Project Engineering Manager

LMP/JVA/bh

cc: L. Popplewell
D.H. Wade
R.E. Ballard
C. Moehlman
J. Van Amerongen

CYGNA	
JOB NO.:	84056
DATE LOGGED:	10/2/84
LOG NO.:	#34
FILE:	2.1.1 Inc. CR
CROSS REF. FILE	2.1 Inc. CR Log

CYGNA QUESTION:

1. CYGNA Question 1 notes that the CCW System may reach 135°F. during recirculation mode (per G&H calculation 223-16) but the TUGCO response only addresses the acceptability of 130°F. CCW. Please provide documentation of the acceptability of 135°F. component cooling water during post accident recirculation mode.

TUGCO RESPONSE:

1. The revision to calculation 223-16 has been voided and the original calculation is being used. The attached documentation verifies the acceptability of 135°F. component cooling water during post accident recirculation mode.

0220 '00/05/10 23:34

WPT-7537

Westinghouse Electric Corporation

Water Reactor Divisions

Nuclear Operations Divisions

Box 355
Pittsburgh Pennsylvania 15230

September 28, 1984

Ref: 1) GTT-10515

Mr. J. T. Merritt, Jr.
Assistant Project General Manager
Texas Utilities Services, Inc.
P.O. Box 1002
Glen Rose, Texas 76043

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
Component Cooling Water Temperature

Dear Mr. Merritt:

The referenced letter requested Westinghouse to review and verify that the stated Component Cooling Water Temperature would be suitable for the Residual Heat Removal Pump Seal Coolers.

Westinghouse's review of Gibbs and Hill's request confirms that the RHR pumps will perform their intended function with 136 F CCW temperatures to the coolers for a period of time of up to 4 hours during recovery from a LOCA.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

R. S. Howard, Manager
WRD Comanche Peak Projects

J.Porterfield/jjs/0987d:1

cc:	J. T. Merritt	1L
	R. D. Calder	1L
	H. C. Schmidt	1L
	R. E. Ballard	1L
	C. B. Hartong	1L
	J. C. Kuykendall	1L
	G. C. Creamer	1L
	ARMB	1L
	J. B. George	1L
	R. A. Jones	1L

Telephone Co .ersation Record

Date: 8/22/79

SMMa/MS-12, EH/JIr, JWM/OMi, KF, OUTGOING 048

Time: 11:00 am

GTN-40147 (9-24-79)

ARMS INDEXED

DATE

Call by: Dino Mirkovic (Name) of G&H (Company)

Answer by: Randy Crawford (Name) of Bingham-Williamette (B-w) (Company)

JOB NO. 35-1195

RECEIVED SEP 28 1979 RECEIVED

Contract No: TUGCo - G&H # 11-2323-001

Subject discussed: Cont. Spray Pumps

P.O. CP-0012

Re: Seal Flush Coolers

SUMMARY OF DISCUSSION, DECISIONS AND COMMITMENTS.

I asked Randy what the maximum temperature of Component Cooling Water can be at the inlet to the seal flush coolers?

The maximum temperature of cooling water can be 200F, cooling water temperature higher than 200F will cause deterioration of O-rings.

DMi/sl

cc: ARMS (G&R Site) OL -
H.C. Schmidt (TUSI Dallas) 2L
J.C. Kuykendall (TUGCo Site) 1L
R.E. Holloway (G&H Dallas) 2L
L.M. Popplewell (G&H Site) 1L
J. T. Merritt (TUSI Site) 1L

B & R DCC DIST.

PROJECT MGR.	
PROJECT ENGR.	
QA MGR.	
PROJECT CONT. ENGR.	
TUGCO QA	
PROJECT GEN MGR.	
ARMS	

F-424 10-68

FORM 7-61 TRM-M

STRUTHERS WELLS

EXCHANGER SPECIFICATION SHEET

DESIGN

JOB NO. TUGC P.O. #CP-0049	
REFERENCE NO. TUSI 05049	
CUSTOMER Texas Utilities Services, Inc.	ORDER NO. 1-74-06-32467
ADDRESS Gibbs & Hill, Inc. - Agent	DATE - 05/12/76
PLANT LOCATION Comanche Peak Steam Elec.Sta.-Units 1 & 2	ITEM NO. 1.0
SERVICE OF UNIT COMPONENT COOLING WATER HEAT EXCHANGER	CONNECTED IN Horizontal
SIZE 61-528 TYPE TEMA CGN	SURFACE PER SHELL 24,360 Eff. 24,708 Gross
SURFACE PER UNIT 48,720 Eff. 49,416 Gross SHELLS PER UNIT Two *	

*Del. 3/1/76 (two units)

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	COOLING WATER		SERVICE WATER	
TOTAL FLUID ENTERING	7,350,000 #/Hr.		7,000,000 #/Hr.	
VAPOR				
LIQUID	7,350,000 #/Hr.		7,000,000 #/Hr.	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY—LIQUID				
VISCOSITY—LIQUID				
MOLECULAR WEIGHT—VAPORS				
SPECIFIC HEAT—LIQUIDS	1.	B.T.U./#	1.	B.T.U./#
LATENT HEAT—VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	114.5	°F	98.4	°F
TEMPERATURE OUT	105.01	°F	108.4	°F
OPERATING PRESSURE	135	#/SQ. IN.	70	#/SQ. IN.
NUMBER OF PASSES	One		One	
VELOCITY	2.6	FT./SEC.	4.7	FT./SEC.
PRESSURE DROP	12.4	#/SQ. IN.	5.3	#/SQ. IN.
CLEANLINESS FACTOR	80.0%			
HEAT EXCHANGED—B.T.U./HR.	70,000,000	M.T.D. (CORRECTED)	6.4	
TRANSFER RATE—SERVICE	451	CLEAN	564	

FOR OFFICE AND ENGINEERING USE ONLY

CONSTRUCTION OF ONE SHELL

	SHELL SIDE		TUBE SIDE	
DESIGN PRESSURE	150	#/SQ. IN.	150	#/SQ. IN.
TEST PRESSURE	225	#/SQ. IN.	225	#/SQ. IN.
DESIGN TEMPERATURE	225	°F	225	°F

TUBES 90/10 Cu-Ni (B-111) NO. 2860 O.D. 3/4" BWG. 18Min LENGTH 44'-0" PITCH 15/16" Tri.

SHELL C.S. A-516-70 I.D. ~~MAX~~ 61" THICKNESS 2Courses 1-1/8" Remainder ¾"

SHELL COVER --- FLOATING HEAD COVER ---

CHANNEL C.S. A-516-70 (Coated) * 1-1/8" Thk. CHANNEL COVER C.S. A-516-70(coated)*

TUBE SHEETS—STATIONARY C.S. w/90/10 Cu-Ni Cladding (3-1/8) FLOATING ---

BAFFLES—CROSS C.S. (3) TYPE Seg.No Tubes in Window THICKNESS 5/8"

BAFFLE—LONG --- TYPE --- THICKNESS ---

TUBE SUPPORTS C.S. (12 Full Supports) THICKNESS 5/8"

GASKETS Compressed Asbestos

CONNECTIONS—SHELL—IN 24" OUT 24" SERIES Butt Weld (Sch.40)

CHANNEL—IN 24" OUT 24" SERIES 150# F.F. Flg.

CORROSION ALLOWANCE—SHELL SIDE 1/8" TUBE SIDE None - Lined

CODE REQUIREMENTS ASME CODE SECTION III, CLASS 3; TEMA CLASS "R"

WEIGHTS—EACH SHELL 101,000 BUNDLE --- FULL OF WATER 160,550

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS: ITEMS CP1-CCA-HHX-01 & 02, CP2-CCA-HHX-01 & 02

SEE PAGE -2- FOR REMARKS.

FORM 7-67 SOM-N

STRUTHERS WELLS

EXCHANGER SPECIFICATION SHEET

PERFORMANCE - INITIAL RECIRCULATION

		JOB NO.	
CUSTOMER	Texas Utilities Services, Inc.	REFERENCE NO.	TUSI 05049
~~ADDRESS~~	Gibbs & Hill, Inc. - Agent	PROPOSAL NO.	7367-N6
PLANT LOCATION	Comanche Peak Steam Elec.Sta.-Units 1 & 2	DATE	6/12/74
SERVICE OF UNIT	COMPONENT COOLING WATER HEAT EXCHANGER	ITEM NO.	1.0
SIZE	61-528 TYPE TEMA CGN	CONNECTED IN	Horizontal
SURFACE PER UNIT	48,720 Eff. 29,416 Gross — SHELLS PER UNIT Two *	SURFACE PER SHELL	24,359 Eff. 24,708 Gross

*Del. 3/1/76 (two units)

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	COOLING WATER		SERVICE WATER	
TOTAL FLUID ENTERING	7,350,000 #/Hr.		7,000,000 #/Hr.	
VAPOR				
LIQUID	7,350,000 #/Hr.		7,000,000 #/Hr.	
STEAM				
NON-CONDENSABLES				
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED				
GRAVITY—LIQUID				
VISCOSITY—LIQUID				
MOLECULAR WEIGHT—VAPORS				
SPECIFIC HEAT—LIQUIDS	1.	B.T.U./#	1.	B.T.U./#
LATENT HEAT—VAPORS		B.T.U./#		B.T.U./#
TEMPERATURE IN	170.5	°F	95.0	°F
TEMPERATURE OUT	135.0	°F	132.0	°F
OPERATING PRESSURE	135	#/SQ. IN.	70	#/SQ. IN.
NUMBER OF PASSES	One		One	
VELOCITY	2.6	FT./SEC.	4.8	FT./SEC.
PRESSURE DROP	12.4	#/SQ. IN.	5.3	#/SQ. IN.
CLEANLINESS FACTOR	----------------------	80.0%	----------------------	

HEAT EXCHANGED—B.T.U./HR.	260,000,000	M.T.D. (CORRECTED)	39.2
TRANSFER RATE—SERVICE	272	CLEAN	340

CONSTRUCTION OF ONE SHELL

DESIGN PRESSURE		#/SQ. IN.		#/SQ. IN.
TEST PRESSURE		#/SQ. IN.		#/SQ. IN.
DESIGN TEMPERATURE		°F		°F

TUBES	NO. O.D. BWG.	LENGTH	PITCH
SHELL	I.D. O.D.	THICKNESS	
SHELL COVER		FLOATING HEAD COVER	
CHANNEL		CHANNEL COVER	
TUBE SHEETS—STATIONARY		FLOATING	
BAFFLES—CROSS	TYPE	THICKNESS	
BAFFLE—LONG	TYPE	THICKNESS	
TUBE SUPPORTS		THICKNESS	
GASKETS			
CONNECTIONS—SHELL—IN	OUT	SERIES	
CHANNEL—IN	OUT	SERIES	
CORROSION ALLOWANCE—SHELL SIDE		TUBE SIDE	
CODE REQUIREMENTS			
WEIGHTS—EACH SHELL	BUNDLE	FULL OF WATER	

NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS:

O/R
HVAC

graham
Vacuum and Heat Transfer

EXCHANGER SPECIFICATION SHEET

CUSTOMER CVI Corp.	EG NO. 270CIN76R2
USER Texas Utilities Generating Co.	JOB NO. 17748M
PLANT LOCATION Comanche Peak Nuclear Plant	CUST. NO. 77-1609
SERVICE OF UNIT R-12 Condenser	DATE 9/25/78
	ITEM NO. --
SIZE 16-5-102 TYPE BEM	POSITION - HORIZ. - VERT. XXX
SURF./UNIT 1170 SQ FT SHELLS/UNIT One	SURF./SHELL 1170 SQ FT
NO. OF UNITS 4 SHELL ARRANGEMENT ---	ENGR. SPN/GAE

PERFORMANCE OF ONE UNIT

FLUID ALLOCATION		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		R-12		Cooling Water	
TOTAL FLUID ENTERING	#/HR	23,784		125,000	
		IN	OUT	IN	OUT
VAPOR	#/HR	23,784	--	--	--
LIQUID	#/HR	--	--	125,000	125,000
STEAM	#/HR	--	--	--	--
NONCONDENSABLES	#/HR	--	--	--	--
FLUID XXXXXXXX CONDENSED	#/HR	--	23,784	--	--
STEAM CONDENSED	#/HR	--	--	--	--
GRAVITY - LIQUID		--	--	1.0	1.0
VISCOSITY - LIQUID	Cps.	--	--	.47	.47
MOLECULAR WEIGHT - VAPORS		120.9	--	--	--
MOLECULAR WEIGHT - NON-CONDENSABLES		--	--	--	--
SPECIFIC HEAT	BTU/LB °F	--	--	1.0	1.0
THERMAL CONDUCTIVITY		--	--	.38	.38
LATENT HEAT		--	--	--	--
TEMPERATURE	°F	195	147	135	145.9
INLET PRESSURE	PSIA	270.4		150	
NUMBER OF PASSES	PER SHELL	One		Two	
VELOCITY	FT/SEC	---		4.8	
PRESSURE DROP - ALLOW/CALC	PSI	6 2		5 4.6	
FOULING RESISTANCE		---		.0005	

HEAT EXCHANGED 1,362,000 BTU/HR MTD (CORRECTED) 17.5 °F

TRANSFER RATE SERVICE 66.5 CLEAN --- BTU/HR SQ FT °F

CONSTRUCTION OF ONE SHELL

SKETCH (BUNDLE/NOZZLE ORIENT.)

		SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE PSIG		350 525	150 225
DESIGN TEMPERATURE °F		200	200
CORROSION ALLOWANCE IN		1/8" on C/S	1/8" on C/S
CONNECTIONS SIZE & RATING	IN	2"-3000#SW	3" 150# RF
	OUT	2"-3000#SW	3" 150# RF

REF: NU-C-1028-1

TUBE NO 260 OD 5/8 IN THK (MIN) XX .049 IN	LENGTH 8'6"
TUBE MATERIAL XX SMLS. SB-359 90/10CuNi PITCH 25/32	IN XXXXXXXXXXXXXXXX
SHELL SA-106 Gr.B ID --- OD 16 IN	SHELL COVER --- (INTEG.) (REMOV.)
XXXXXX BONNET SA-106 Gr.B/SA-285Gr.C	CHANNEL COVER ---
TUBESHEET - STATIONARY SA-171 CDA 706	TUBESHEET - FLOATING ---
FLOATING HEAD COVER ---	IMPINGEMENT PROTECTION SA-240 304 S/S
BAFFLES - CROSS SA-285 Gr.C TYPE 4-Segm. % CUT 25	SPACING 4"
BAFFLES - XXXX Subcooling weir SA-285 Gr.C	SUPPORTS SA-285 Gr.C
TUBE SHEET JOINTS - SHELL Welded CHANNEL Flanged	TUBES Expanded
GASKETS - SHELL --- FLOATING HEAD ---	CHANNEL Neoprene
CODE REQUIREMENTS *	TEMA CLASS R
WEIGHTS SHELL - SHIPPING FLOODED	LBS

REMARKS *ASME Sect. III, Class 3 (Tubeside)/Section VIII, Div. 1 (Shellside), 1974 Edition-Winter 1976 Addenda

Tubes per SB-359 90/10 Cu.Ni. CDA 706 Code Case 1634-1.

Tubes have 26 fins per inch.

S 10/CR

THERMAC ASSOCIATES

APPROVED
FOR ARRANGEMENT ONLY
PROCEED WITH FABRICATION
SUBJECT TO COMPLIANCE WITH
ALL CONTRACT REQUIREMENTS.
DRAWINGS, AND SPECIFICATIONS.

NOV 1 0 1976

GIBBS & HILL, INC.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

PERFORMANCE CURVE
AND
CORRECTION CURVE
FOR
CONTAINMENT SPRAY HEAT EXCHANGERS

TEXAS UTILITIES SERVICES, INC. P.O. #CP-0050
OAT J-2275

BY

Martin Walsh
MARTIN WALSH
PROJECT ENGINEER
JOSEPH OAT CORPORATION

REPORT #TM-214

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** PROCESS DATA **                                  COLD SHELL SIDE      HOT TUBE SIDE
 1 NAME OF FLUID                                     COM.COOL.WTR         BORATED WTR
 2 FLUID CONDITION                                   SENS. LIQUID         SENS. LIQUID
 3 TOTAL FLOW RATE                   (M-LB/HR)        3043.483             2503.322

 4 TEMPERATURE, IN /OUT     (DEG.F)        115.0 /  171.0*       233.4  /  175.0*
 5 TEMPERATURE, AVG./SKIN    (DEG.F)         143.0/  167.2         204.2/   183.3
 6 PRESSURE,   INLET/AVG.     (PSIA)         135.0/  130.0         250.0/   242.5

 7 PRESSURE DROP, TOTAL/ALLOW.    (PSI)        8.57/  10.00          14.44/   15.00
 8 VELOCITY, CALC./MAX.ALLOW.  (FT/SEC)        3.26/   5.00           9.50/   15.00

 9 FILM COEF. (SAF.FAC)   (BTU/HR-FT2-F)    1451.84 ( .80)     1932.43 ( .80)
10 FOULING RESISTANCE     (HR-FT2-F/BTU)         -0.00000            -0.00000

11 DENSITY                      (LB/FT3)          61.2407             60.0366
12 THERMAL COND.             (BTU/HR-FT-F)          .3730               .3833
13 SPEC. HEAT                  (BTU/LB-F)           .9973              1.0012
14 VISCOSITY AT AVG. TEMP. (CENTIPOISE)             .46078              .29586
15 VISCOSITY AT SKIN TEMP. (CENTIPOISE)             .38052              .33919

** OVERALL PERFORMANCE DATA **
16 TOTAL HEAT DUTY REQUIRED           (MM-BTU/HR)                   169.854068
17 EFF. TEMP. DIFF.,(LMTD)(F)(DELTA)=  (DEG.F)      61.2( .83)(1.00)=  50.9
18 OVERALL COEF., REQUIRED        (BTU/HR-FT2-F)                     577.13
19 OVERALL COEF., CLEAN/ACTUAL    (BTU/HR-FT2-F)      574.16 /       574.16

** CONSTRUCTION INFORMATION **
20 NO. SHELLS SERIES  1 PARALLEL 1    TOTAL SURF. AREA  (FT2/UNIT)        5866
21 NO. PASSES SHELL   1 TUBES    2    EFF. SURF. AREA  (FT2/SHELL)      5780.9
22 SHELL DIAMETER  (IN)     43.000    TEMA- SHELL TYPE  E  REAR HEAD       UT

23 BAFFLE TYPE     -HORZ-NO TUBES     NO. CROSS PASSES/SHELL PASS            5
24 SPACING,CENTRAL   (IN)   59.630    BAFFLE CUT        (PCT.DIA.)       19.20
25 SPACING,INLET     (IN)   59.630    BAFF.CUT,AREA 1) 21.4 2)  0.0 3)    0.0
26 SPACING,OUTLET    (IN)   48.500    CUT,HEIGHT FROM CENTER LINE (IN)
27 BAFFLE THICKNESS  (IN)     .625    POS.#1)    13.2 2)     0.0 3)       0.0

28 NO. PAIRS SEAL DEVICES        0    IMPINGEMENT BAFFLE INCLUDED           NO
29 TOT.TUBE SHEET THICK.(IN)   4.3    PERCENT TUBES REMOVED    (BOTH)   0.000

30 TUBE TYPE                 PLAIN    NO. OF TUBES/SHELL                  1220
31 TUBE LGTH,OVERALL (FT)   24.492    TUBE PITCH                (IN)     .9375
32 TUBE LGTH,EFFECT. (FT)   24.133    TUBE O.D.                 (IN)      .750
33 TUBE LAYOUT       (DEG)      30    TUBE I.D.                 (IN)      .652
34 PITCH RATIO               1.250    SURFACE AREA RATIO  (OUT/IN)       1.150
36 WEIGHT ESTIMATION /SHELL   (LB)    DRY          23528   WET           46181
**WARNING -ESTIMATED TUBE COUNT FOR THIS SHELL SIZE IS       1762 TUBES. THE
  PROGRAM USED THE INPUT VALUE OF       1220 TUBES IN  CALCULATIONS.

DISTANCE FROM TANGENT POINT TO LAST BAFFLE EQUALS    37.13 (IN)
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** SHELL SIDE PERFORMANCE **
 1 NOM. VEL.  X-FLOW/WIND.       3.64/  10.19
 2 FILM COEF.,X-FLOW/WIND.   1931.8/     0.0
 3 FLOW FRACTIONS      HEAT TRANSFER B= .783
 4 A= .10  B= .740  C= .10  E= .06  F=0.00
** SHELL-SIDE HEAT TRANSFER CORRECTIONS
 5  TOTAL   #BETA#   #GAMA#   #END#   #FIN#
 6   .920    .920    1.000   1.021   1.000

** PRESSURE DROPS ** (PCT. TOTAL SHELL DP)
 7 NOZZ (IN/OUT)  6.95/  7.03  WIND   8.18
 8 END 24.64/TUBE NOZZ DP.-PCT. TOT.  9.09

** H.T. PARAMETERS **            SHELL    TUBE
 9 WALL CORRECTION               1.027    .981
10 PRANDTL NO.                     3.0     1.9
11 REYNOLDS NO. AVG.             42660  155992
12 REYNOLDS NO. IN. BUN.         33105  184832
13 REYNOLDS NO. OUT. BUN.        53120  128378
14 FOULING LAYER        (IN)-0.00000-0.00000

** THERMAL RESISTANCES ** (PCT. OVERALL)
15  SHELL   TUBE  FOULING  METAL   OVER DES.
16  39.55  34.18    0.00   26.28       -.51
17 TOTAL FOULING RESISTANCE        0.000000
18 DIFFERENTIAL  RESISTANCE        -.000009

** SHELL NOZZLE INFO. **        INLET  OUTLET
19 NOZZLE I.D.         (IN)      17.3    17.3
20 VELOCITY        (FT/SEC)      8.45    8.58
21 DENSITY         (LB/FT3)    61.682  60.731

22 NOZZ.R-V-SQ  (LB/FT-S2)       4399    4468
23 BUND.R-V-SQ  (LB/FT-S2)       1144    1162
24 HEIGHT UNDER NOZZ  (IN)        8.5     8.5

** TUBE  NOZZLE INFO. **        INLET  OUTLET
25 NOZZLE I.D.         (IN)      15.3    15.3
26 VELOCITY        (FT/SEC)     10.71   10.48
27 DENSITY         (LB/FT3)    59.344  60.653

** DIAMETRAL CLEARANCES **
28 BAFFLE TO SHELL          (IN)      .1875
29 BUNDLE TO SHELL          (IN)     1.0000
30 TUBE TO BAFFLE HOLE      (IN)      .0156
31 BAFF.OVERLAP MULTI-SEG.  (IN)      0.000
```

WPT-2729

HEAT EXHANGER DATA SHEET

SERVICE 'Residual Heat Exchanger RHAHRS IDENT. RS-681 JOB J-2300-1

TYPE BEU Vertical SQ. FT. PER SHELL 6627 SHELLS, IN SERIES/PARAL. 1

SIZE 43-271 SQ. FT. PER UNIT 6627 TEMA CLASS R

PERFORMANCE OF UNIT

OPERATION MODE	DESIGN					
HEAT EXCHANGED, BTU/HR	39.1×10^6					
LMTD (FACTOR) ∆ T	19.1(.89)1.0=17.					
OVERALL COEF., CLEAN/SERVICE	527.5/364.8					
$BTU \times HR^{-1} \times {}^{\circ}F^{-1} \times FT^{-2}$	SHELL SIDE	TUBE SIDE	SHELL SIDE	TUBE SIDE	SHELL SIDE	TUBE SIDE
FLUID ENTERING	SERVICE WTR	PROCESS WTR				
TOTAL FLUID, LB/HR	3.8×10^6	1.9×10^6				
LIQUID, LB/HR	3.8×10^6	1.9×10^6				
VAPOR, LB/HR						
NON-COND'S, LB/HR						
VAPOR'D OR CONDENSED						
TEMP, IN/OUT °F	105/115.3	140/119.4				
SPECIFIC GRAVITY						
VISCOSITY (LIQUID), CP						
CONDUCTIVITY (LIQUID)						
PASSES	1	2				
VELOCITY, FT/SEC	5.5*	5.1				
PRESSURE AT INLET, PSI						
PRESSURE DROP, PSI	16	6.0				
FOULING RESISTANCE	.0005	.0003				

CONSTRUCTION OF ONE SHELL

		SHELL SIDE	TUBE SIDE
PRESS., PSI -- DESIGN/TEST		150/225	600/900
DESIGN TEMP °F		200	600
ASME CODE CLASS		Section III Class 3	Section III Class 2
CONNECTIONS (SIZE & FACING)	IN	24" 150# WNRF Flange	12" Sch x STG Butt Weld
	OUT	24" 150# WNRF Flange	12" Sch x STG Butt Weld
	OTHER		
GASKET & JOINT STYLE		Spiral Wound - Retained	Spiral Wound-Retained
CORR. ALLOWANCE		0.125"	0.005" On Tubes

TUBE TO T.S. JOINT Welded and rolled IMPINGEMENT PLATE Deflector at Inlet

TUBES NO. 729 O. D. 0.75" GUAGE 18 BWG LENGTH Max. St. Lgth./Leg=22'7"

SHELL I. D. 43.25" O. D. 44.25" TUBE PITCH 1" ▲ □

BAFFLES CROSS TYPE Triple Sgmtl. SPACING 9.5" ; LONG TYPE None

WEIGHT - LBS. EMPTY 29,400 FULL 47,000 BUNDLE 16,600

PART	MATERIAL	THK. IN.	PART	MATERIAL	THK. IN.
TUBES	SA249-304	.049	T. S. - FIXED	SA516-70	5.625
SHELL	SA516-70	.50	~~T. S. - FLOATING~~	304 S/S Weld Overlay	.375
SHELL COVER	SA516-70	.50	CROSS BAFFLE	SA36	.375
CHANNEL	SA240-304	1.0	LONG BAFFLE	----	
CHANNEL COVER	SA240-304	.875	OTHER Impinge.	Plate SA36	.625

REMARKS *Max. value corresponding to max. span of 28.50"

NO	ISSUE	DATE	ENG''	APR'D
1	Initial Design	9/14/7[illegible]	[illegible]	Chhina
2	Revised	11/12/7[illegible]	[illegible]	Chhina

BRF-11163

INCORPORATED
P.O. BOX 2138, COLUMBUS, OHIO 43216 • (614) 876-7381 • TELEX 246-3

CRYOGENIC NUCLEAR EQUIPMENT

OPERATION AND MAINTENANCE MANUAL

UPS AND DISTRIBUTION ROOM AIR CONDITIONING UNITS

CPX-VAACUP-01
CPX-VAACUP-02

PREPARED FOR

TEXAS UTILITIES P.O. CP-0087
GIBBS & HILL SPECIFICATION 2323-MS-87

FOR USE AT

COMANCHE PEAK NUCLEAR STATION - UNITS 1 & 2
GLEN ROSE, TEXAS

CVI WORK ORDER C581

FOR OFFICE AND
ENGINEERING USE ONLY

AUGUST 1982

UPS

Graham
Vacuum and Heat Transfer

EXCHANGER SPECIFICATION SHEET

1		EG NO.	145-CIN-81-R1
2 CUSTOMER	CVI Corporation	JOB NO.	
3 USER		CUST. NO.	81-1904
4 PLANT LOCATION		DATE	May 29, 1981
5 SERVICE OF UNIT	R-12 Condenser	ITEM NO.	
6 SIZE	16-5-76 TYPE BEM	POSITION - HORIZ./XXXX	
7 SURF./UNIT	827 SQ. FT. SHELLS/UNIT One	SURF./SHELL	827 SQ. FT.
8 NO. OF UNITS	Two SHELL ARRANGEMENT	ENGR.	

PERFORMANCE OF ONE UNIT

		SHELL SIDE		TUBE SIDE	
9 FLUID ALLOCATION		SHELL SIDE		TUBE SIDE	
10 FLUID CIRCULATED		R-12		Water	
11 TOTAL FLUID ENTERING	#/HR	8016		45,000	
12		IN	OUT	IN	OUT
13 VAPOR	#/HR	8,016			
14 LIQUID	#/HR			45,000	
15 STEAM	#/HR				
16 NONCONDENSABLES	#/HR				
17 FLUID XXXXXXXXXXX CONDENSED	#/HR		8,016		
18 STEAM CONDENSED	#/HR				
19 GRAVITY - LIQUID				.99	
20 VISCOSITY - LIQUID				.47	
21 MOLECULAR WEIGHT - VAPORS					
22 MOLECULAR WEIGHT - NON - CONDENSIBLES					
23 SPECIFIC HEAT	BTU/#/°F			1.0	
24 THERMAL CONDUCTIVITY				.38	
25 LATENT HEAT					
26 TEMPERATURE TSAT = 150	°F	190	145	135	146.2
27 INLET PRESSURE		250 PSIA		---	
28 NUMBER OF PASSES	PER SHELL	One		Four	
29 VELOCITY	FT./SEC.	---		3.6	
30 PRESSURE DROP - ALLOW/CALC	PSI	--- / 1.0		--- / 3.5	
31 FOULING RESISTANCE		---		.0005	

32 HEAT EXCHANGED 506,000 BTU/HR MTD (CORRECTED) Avg'd. 10.6 °F

33 TRANSFER RATE SERVICE Avg'd. 57.7 CLEAN 67.9 BTU/HR SQ FT °F

CONSTRUCTION OF ONE SHELL

SKETCH (BUNDLE/NOZZLE ORIENT.)

		SHELL SIDE	TUBE SIDE
34		SHELL SIDE	TUBE SIDE
35 DESIGN/TEST PRESSURE PSIG		350 / code	150 code
36 DESIGN TEMPERATURE °F		200	200
37 CORROSION ALLOWANCE IN		1/8"	1/8"
38 CONNECTIONS	IN	1-1/2"	2"
39 SIZE &	OUT	1-1/2"	2"
40 RATING		3,000 lbs. SW	150 lb. R.F.

FOR OFFICE AND ENGINEERING USE ONLY

41 TUBE NO. 250 OD 5/8 IN. THK(MIN/AVG) .049 IN. LENGTH 6'4"

42 TUBE MATERIAL (WLD/SMLS) SB359 CDA706* PITCH 25/32 IN 30 XXXXXXXXXXXXX

43 SHELL C/S ID 15-1/4 OD 16 IN. SHELL COVER -- (INTEG.) (REMOV.)

44 XXXXXXXX BONNET C/S CHANNEL COVER --

45 TUBESHEET - STATIONARY SB171 CDA706 (90-10) TUBESHEET - FLOATING --

46 FLOATING HEAD COVER -- IMPINGEMENT PROTECTION Yes

47 BAFFLES - CROSS C/S TYPE Segmental % CUT -- SPACING --

48 BAFFLES - LONG -- TUBE SUPPORTS --

49 TUBE SHEET JOINTS - SHELL Welded CHANNEL Flanged TUBES Rolled and Welded

50 GASKETS - SHELL -- FLOATING HEAD -- CHANNEL Neoprene

51 CODE REQUIREMENTS Tubeside ASME Sec III Cl.3/shellside ASME Sec. VIII TEMA CLASS "R"

52 WEIGHTS/SHELL - SHIPPING -- FLOODED LBS.

53 REMARKS *Tubes per SB359 90-10 CuNi Code Case N-68. Tubes are Wolverine

54 26 FPI.

55 C581-9907 Page 3 of 5

Rev N/C

S 1012R

PERFORMANCE TEST REPORT
FOR
YORK HERMETIC TURBOPAK
MODEL HTC2A1-ABCS, REFRIGERANT-11
NUCLEAR SAFETY RELATED CENTRIFUGAL WATER CHILLER UNIT

CUSTOMER: TEXAS UTILITIES GENERATING COMPANY
P. O. BOX 2300
GLEN ROSE, TEXAS 76043
PURCHASE ORDER NUMBER CP-0080B

AGENT: TEXAS UTILITIES SERVICES, INC.
2001 BRYAN TOWER
DALLAS, TEXAS 75201

CONSULTING ENGINEERS: GIBBS & HILL, INC.
393 SEVENTH AVENUE
NEW YORK, NEW YORK 10001
SPECIFICATION 2323-MS-80B
ADDENDUM NO. 1, DATED SEPTEMBER 15, 1978

PROJECT: COMANCHE PEAK STEAM ELECTRIC STATION
UNITS 1 AND 2
GLEN ROSE, TEXAS

APPROVED
FOR ARRANGEMENT ONLY
PROCEED WITH FABRICATION
SUBJECT TO COMPLIANCE WITH
ALL CONTRACT REQUIREMENTS,
DRAWINGS AND SPECIFICATIONS.
JUL 20 1979
GIBBS & HILL, INC.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

UNIT IDENTIFICATION: WATER CHILLER ITEM NUMBER
CP2-CHCICE-06
YORK SERIAL NUMBER 8-1965
YORK ORDER NUMBER 77-780931(H)

SUBMITTED BY: YORK DIVISION, BORG-WARNER CORPORATION
YORK, PENNSYLVANIA
JUNE 21, 1979
TRANSMITTAL NO. Y-124

PREPARED BY: A. R. Shanko, Jr.
A. R. SHANKO, JR.
CONTRACT ENGINEER

RECEIVED
JUN 22 1979
GIBBS & HILL, INC.

APPROVED BY: R. E. Dolheimer
R. E. DOLHEIMER
CHIEF CONTRACT ENGINEER

J. J. Bertz
J. J. BERTZ
QUALITY ASSURANCE MANAGER

CUSTOMER COMANCHE PEAK STEAM ELECTRIC STATION. S.O. No. 77-780,931(H)

PRINCIPAL EQUIPMENT UNDER TEST HTC2A1-ABCS R-11 HERMETIC TURBOPAK

DATA RECORDED BY (SEE BELOW) ENGINEER A.R. SHANKO, JR.

TEST REQUEST NO. —
YORK DIVISION
BORG-WARNER CORPORATION
ENGINEERING DEPARTMENT

1979 TIME Date	Hour	AMBIENT BARO. PSIA	AMBIENT °F	AMBIENT Room °F	EVAPORATOR Flow Meter	EVAPORATOR CPS	EVAPORATOR GPM	EVAPORATOR H_2O ON °F	EVAPORATOR H_2O OFF °F	EVAPORATOR H_2O ΔP PSI	EVAPORATOR Evap. Press. "Hg	EVAPORATOR Evap. Temp. °F	CONDENSER Flow Meter	CONDENSER CPS	CONDENSER GPM	CONDENSER H_2O ON °F	CONDENSER H_2O OFF °F	CONDENSER H_2O ΔP PSI	CONDENSER Cond. Press. PSIG	CONDENSER Liq. Temp. °F	COMPRESSOR Suct. Temp. °F	COMPRESSOR Disch. Temp. °F	COMPRESSOR Oil Press. PSI	COMPRESSOR Vanes %	OIL COOLER Oil In °F	OIL COOLER Oil Out °F
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		Panel		Digital 582-4	#2	Panel		Digital 582-1	Digital 634-2				#1	Panel		Digital 579-1	Digital 579-2			Digital 579-3	Digital 634-1	Digital 579-4			TC 1	TC 2
		EMERGENCY CONDITION ~ TEST RUN No. 1																								
6/18/79																										
	1210	14.42		77.1		106		70.8	61.5	6.5	8.2			118	-	135.7	145.8	5.5	35.6	142.9	62.32	194.6	98	35%	119	105
	1225	14.42		77.2		106		70.8	61.6	6.5	8.1			119	-	135.8	145.9	5.5	35.7	142.7	62.46	195.0	98	35%	118	105
	1240	14.42		77.1		10.5		70.8	61.6	6.5	8.1			118		135.8	145.9	5.5	35.9	142.8	62.48	194.8	97.5	35%	120	106
AVERAGE:		14.42	80	77.13	—	105.67	257.4	70.8	61.57	6.5	8.13	59.2	—	118.33	307.9	135.76	145.87	5.5	35.7	142.8	62.42	194.8	97.8	35%	119	105.3
										15 FT.								12.7 FT.	147.4 F							

ENGINEERING LABORATORY TEST RECORD SHEET A

YORK OPERATORS:

[illegible signature]

R. [illegible signature]

WITNESSED BY:

[illegible signature] Quality Assurance

A.R. Shanko, Jr. Contract Engr.

[illegible signature] [illegible date]

SAT, DEC 1, 77, 11:22 AM

USER NAME COMANCHE PEAK STEAM ELECTRIC STATION

LOCATION GLEN ROSE, TEXAS

77-780931 H

BY A.R. SHANKO, JR.

NO. UNITS 4

POWER INPUT 103 KW

MAXIMUM KW = 125

VOLTS 460 / 3 / 60

FLA 144

LRA DELTA 747

LRA STAR ——

STARTER TYPE ACROSS-THE-LINE

APPROVED FOR ARRANGEMENT ONLY PROCEED WITH FABRICATION SUBJECT TO COMPLIANCE WITH ALL CONTRACT REQUIREMENTS, DRAWINGS, AND SPECIFICATIONS.

FEB 3 19..

GIBBS & HILL, INC.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

TURBOPAK MODEL NO HTC2A1-ABCS UNIT DUTY 101 TR BASIC CONDITION

	CONDENSER	COOLER
FLUID TYPE	WATER	WATER
GPM	300.	255.
TEMP ON - F	105.0	64.5
TEMP OFF - F	115.5	55.0
FOULING FACTOR	.00050	.00050
PASSES	3	3
TUBE VEL - FPS	6.17	5.92
PRESS DROP - FT	13.09	13.69
TUBE MATL & NO.	COPPER - 184	COPPER - 163
EXT SURF - SQ FT	1623. (26 FPI)	1438. (26 FPI)
DWP - WATER SIDE	150 PSIG	150 PSIG

COMPR MODEL A1 SPEED CODE LW REFR 11

Mech.
CHILLER

SAT., DEC 1 1977, 11:24 AM

USER NAME COMANCHE PEAK STEAM ELECTRIC STATION

LOCATION GLEN ROSE, TEXAS

77-780931 H

BY A. R. SHANKO, JR.

NO. UNITS 4

POWER INPUT 125.5 KW

MAXIMUM KW = 126

VOLTS 460 / 3 / 60

FLA 175.3

LRA DELTA 747

LRA STAR ——

STARTER TYPE ACROSS-THE-LINE

TURBOPAK MODEL NO HTC2A1-ABCS UNIT DUTY 101 TR EMERGENCY CONDITION

	CONDENSER	COOLER
FLUID TYPE	WATER	WATER
GPM	300.	255.
TEMP ON - F	135.0	71.5
TEMP OFF - F	146.0	62.0
FOULING FACTOR	.00050	.00050
PASSES	3	3
TUBE VEL - FPS	6.17	5.92
PRESS DROP - FT	12.44	13.41
TUBE MATL & NO.	COPPER - 184	COPPER - 163
EXT SURF - SQ FT	1623. (26 FPI)	1438. (26 FPI)
DWP - WATER SIDE	150 PSIG	150 PSIG

COMPR MODEL A1 SPEED CODE LH REFR 11

Nuclear chiller

IU · [illegible]

Gibbs & Hill, Inc. Job No. Client

Subject

Calculation Number Sheet No.

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Drawing Revised		X		X		X		X		X
Preparer										
Checker										

VENDOR ACCEPTED CCW Temperatures:

EQUIPMENT experiencing LOCA conditions	Design DESIGN TEMP. °F	NORMAL OPER IN/OUT CCW TEMP. °F	EMERGENCY OPER. IN/OUT CCW TEMP °F	REFERENCE
CCW HX	225	114.5/105	170.5/135.0	EQUIPMENT DESIGN MANUAL
NUCLEAR CHILLER		105/115	135/146	PERFORMANCE DATA
CONTROL ROOM A/C	200	not available	135/146	EQUIPMEN DESIGN MANUAL
CT. PUMP SEAL COOLER	200	———	——→	GTN-40147
CT. HX.	200	115/171	*NC-CT-6	REPORT TM. 214 CP.CTO
RH PUMP SEAL COOLER		105/ Info to be seek		from (W) WPT-2130
RH. HX	200	105/115	*NC-CT-6	WPT-2729 Westinghouse N.S.D.
UPS A/C COND.	200	Not available.	135/146.2	EQUIPMENT DESIGN MANUAL

* Ultimate heat sink calc n° NC-CT-6 uses CCW temp of 135°F.

Checking Method #
1. Line by line checking
2. Alternate Calculation Results compared
3. Alternate Calculation Results compared
4. Compare inputs and results of computer with comparable inputs and results of similar codes

F-166, 7-82

REF: 84056.022 PROJECT FILE

Distribution

N. Williams
J Russ
W Horstman
84056 Project File

CYGNA QUESTION

JOB NO.: 84056
DATE LOGGED: 10/1/84
LOG NO.: #32
FILE: 2.1.1 Inc. CR / 2.1 Inc. CR Log

5. Regular Case SP-4; Support Numbers 638, 3026

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.

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:

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

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, I.6-1b and I.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;

(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.

TUGCO RESPONSE:

(a) For longitudinal and transverse loads (in the plane A frame) the frame is considered rigid and the resulting moments were considered in the design. However, when considering vertical loads, because of large differences in stiffness between the two members, only a small fraction of the fixed end moment goes to member AE as a torsional moment. Refer to the explanation at the end of the next page. Since this is very small, it is neglected.

(b) A load reduction of 25% was used because the span between SP 4 and the next support is allowed to be 8 ft. maximum. The share of the SP 4 is ½X8+ cantilever portion of tray (2'-0 max.). 4+2=6'-0 which corresponds to 25% reduction.

(c) Column 8 of SCS-101C Set 3, sheets 92 and 93 should read:

$$f_{by} = F_{by} \times \left[1 - \left(\frac{f_a}{F_a}\right)^2 - \left(\frac{f_{bx}}{F_{bx}}\right)^2 \right]^{1/2}$$

Whe $F_a = 12.07$ ksi for $KL/r = \frac{4 \times 12}{.45} = 107$

$F_{by} = F_{bx} = 22$ ksi

However, the final results shown in the attached sheets 3/92a & 3/92b are identical.

TUGCO RESPONCE: (No. 5 cont.)

(d) From column 9 of SCS-101C Set 3, sheets 92 and 93, the effect due to fixed end moments in the brace angle is $\frac{0.63\ K}{6}\sqrt{2} = 0.15\ K$.

This when added by RMS to the axial force due to transverse load is negligeable.

(e) Inadvertently P was compared with Fa instead of Fa X A. However, since A is greater than 1 ($A = 2.11\ in.^2$), this does not affect the result.

(f) As shown in item (d) above, the moment to be carried to the brace connection base angle is 0.63 K or $\frac{.63}{6} \times \frac{6}{4} = 0.16\ K$ as additional shear and tension.

From calculation SCS-101C Set 3, sheet 95

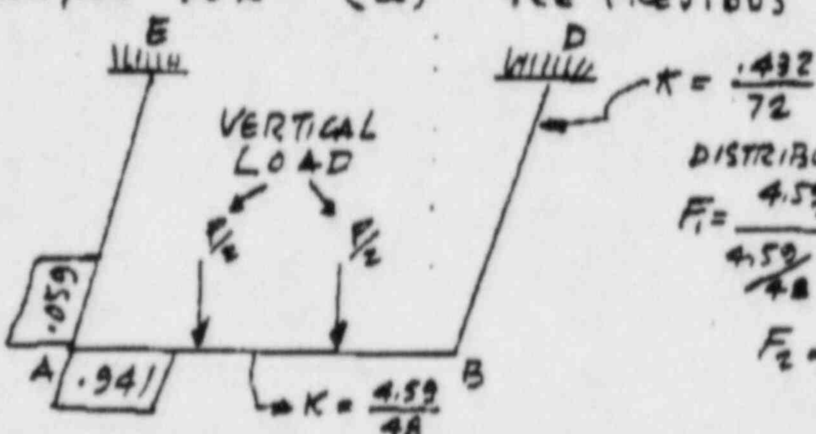
$$T = [\ 2.69^2 + .16^2]^{1/2} = 2.694K$$

$$V = [\ 1.79^2 + .16^2]^{1/2} = 1.8K$$

This shows that there is no significant change.

(g) Refer to the attached calculations for verification that all stresses are relatively low. Since support 3026 carries only one 12" tray there was no need for bracing.

EXPLANATION FOR (a) SEE PREVIOUS SHEET



DISTRIBUTION FACTOR

$$F_1 = \frac{4.59/48}{\frac{4.59}{48} + \frac{.432}{72}} = .941$$

$F_2 = .059$

MAX FIXED END MOMENT @ AB DUE TO VERTICAL LOAD (SEE SCS-101C SH. 3/92 COL 5)
$M = .6195 \times \frac{6}{8}$ PEAK AND .059 TIMES OF IT GOES TO "AE" MEMBER AS A TORSIONAL MOMENT WHICH CREATES ADDITIONAL STRESS OF

$f_{b_1} = \frac{a \times T}{d \times S} \times \tanh \frac{L}{a}$ WHERE $a = 6.25\ IN$; $d = 4\ IN$; $S = .343/2\ IN^3$; $L = 72\ IN$

$f_{b_1} = \frac{6.25 \times .6195 \times 6/8 \times 12 \times .095}{4 \times .343/2} \times \tanh \frac{72}{6.25} = 2.95\ KSI$ TOTAL STRESS ON AE MEMBER

$f_b = 2.95 + 19.48 \times \frac{5.5}{6} = 20.8\ KSI$ WHERE 19.48 TAKEN FROM SCS-101C SH. 3/94 AND REDUCED $\frac{5.5}{6}$ TIMES BECAUSE OF L 6x6 CONNECTION ANGLE

OR USING INTERACTION FORMULA $\left[\left(\frac{.398}{5.83}\right)^2 + \left(\frac{20.8}{22}\right)^2\right]^{\frac{1}{2}} = .948 < 1$ (MEMBER OK)

5.83 ⟶ FOR $\frac{KL}{r_y} = \frac{72}{.450} = 160$

TUGCO NUCLEAR ENGINEERING - CPSES

CALCULATION SHEET

Subject ______________________ Sheet ______ of ______

Originator E.K Date 8/30/84

Checker ______ Date ______

Calculation No. ______ Revision ______ Checking Method No. ______

SH. 2/(c)/2a

8	9	10	11
f_{by} (KSI)	M_Y (Ft-Kips)	P_L (KIPS)	L_{MAX} (Ft)
21.9376	.6270	1.3377	67.05
21.9319	.6269	1.3374	47.76
21.9194	.6265	1.3366	30.55
21.9135	.6264	1.3362	22.20
21.9022	.6260	1.3355	16.97
21.9066	.6262	1.3358	15.09
21.8957	.6259	1.3352	13.48
21.9021	.6260	1.3355	11.92

Checking Method No. 1. Line-by-line
2. Identical Calculation Results Compared
3. [illegible]

Form TNE OC-3.1

TUGCO NUCLEAR ENGINEERING - CPSES

CALCULATION SHEET

Subject ______________________

Sheet ______ of ______

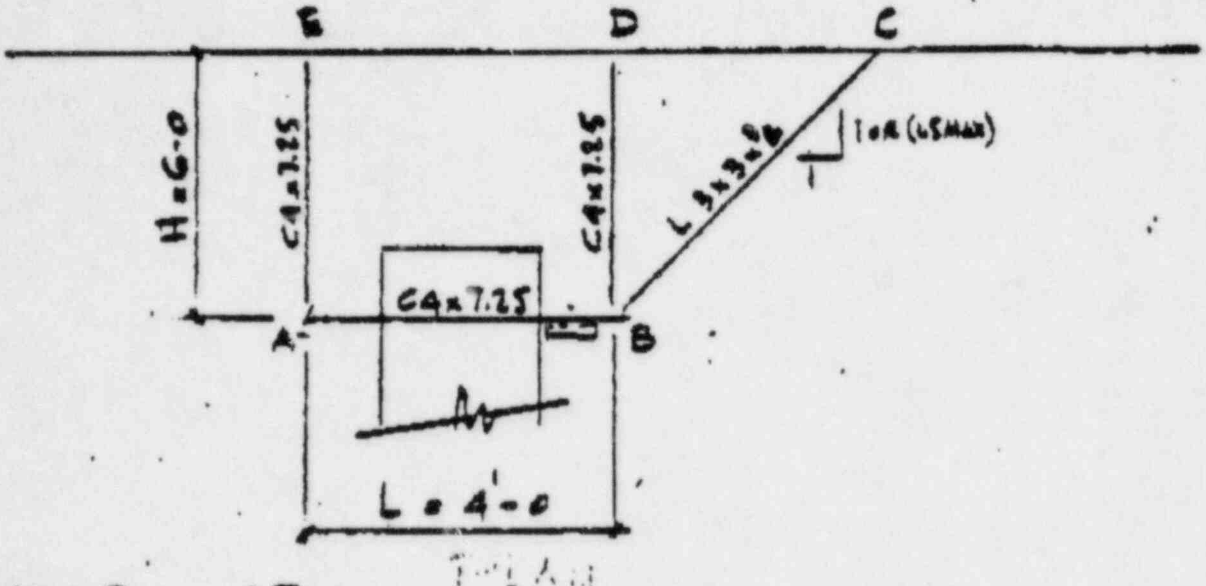
Originator E.K. Date 8/30/84

Checker ______ Date ______

Calculation No ______ Revision ______ Checking Method No. ______

3/93

8	9	10	11
f_{bY} (KSI)	M_Y (Ft-Kip)	P_L (Kips)	L_{max} (Ft)
21.8392	.6242	1.6646	41.72
21.8239	.6238	1.6635	29.70
21.7902	.6228	1.6609	18.98
21.7722	.6223	1.6595	13.78
21.7390	.6214	1.6570	10.52
21.7478	.6216	1.6577	9.36
21.7169	.6207	1.6553	8.36
21.7291	.6211	1.6562	7.39



MEMBER AB:

CONSIDERED FIXED AT THE ENDS AND COMPUTATION MADE FOR VARIOUS G VALUE GIVEN FOR PARTICULAR ELEVATIO[N] FOR EACH BUILDING. ✓

CASE 1:

ONE FT. TRAY SUPPORTED AT MIDSPAN

CASE 2:

TWO FT. TRAY SUPPORTED AT MIDSPAN

FOR BOTH CASES ASSUMED 8 FT SPAN FOR VERTIC[AL] AND TRANSVERS LOAD AND MADE INVESTIGATION TO FIND OUT L_{MAX} FOR LONGITUDINAL LOAD WHICH SATISFY FORMULA: ✓

[illegible]

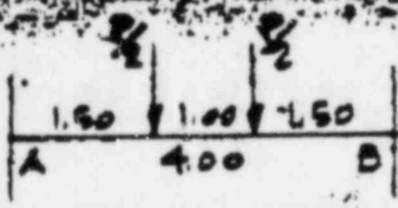
Date 11/8/78 **Gibbs & Hill, Inc.** Filing Code SCL 101C

Calc By ENZaid **ENGINEERS DESIGNERS CONSTRUCTORS** Sheet No. 3/92

Chk'd By NBS **NEW YORK** G&H Job No. 2323

Subject SP-4 TYPE SUPPORT 5-090

CASE 1 :



M = .46875 P

1	2	3	4	5	6	7	8	9	10	11
G_V	G_H	P_V (KIPS)	P_T (KIPS)	M_X (FT-KIPS)	f_a (KSI)	f_{bx} (KSI)	f_{by} (KSI)	M_Y (FT-KIPS)	P_L (KIPS)	L_{MAX} (FT)
2.40	.57	.672	.1596	.315	.0749	1.6507	21.9379	.6271	1.3378	67.06
2.50	.80	.700	.224	.3281	.1052	1.7193	21.9325	.6269	1.3374	47.75
2.70	1.25	.756	.350	.3544	.1643	1.8571	21.9209	.6266	1.3367	30.55
2.77	1.72	.7756	.4816	.3636	.2261	1.9053	21.9162	.6264	1.3363	22.20
2.91	2.25	.8148	.630	.3819	.2958	2.0012	21.9068	.6262	1.3359	16.96
2.81	2.53	.7868	.7084	.3688	.3326	1.9326	21.9124	.6263	1.3361	15.09
2.95	2.83	.826	.7924	.3872	.3720	2.029	21.9031	.6261	1.3357	13.49
2.80	3.20	.784	.896	.3675	.4207	1.9256	21.9115	.6263	1.3361	11.93

1. G_V ; 2. G_H 3. $P_V = .035 \times 1. \times 8. \times G_V$ ✓

4. $P_T = .035 \times 1. \times 8. \times G_H$ ✓ 5. $M_X = .46875 P_V$ ✓

6. $f_a = \frac{P_T}{2.13}$ ✓ 7. $f_{bx} = \frac{M_X \times 12}{2.29}$ ✓

8. $f_{by} = \left[22^2 - f_a^2 - f_{bx}^2\right]^{\frac{1}{2}}$ ✓ 9. $M_Y = \frac{f_{by} \times .343}{12}$ ✓

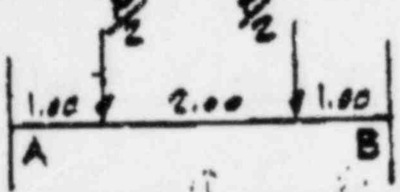
10. $P_L = \frac{M_Y}{.46875}$ ✓ 11. $L_{MAX} = \frac{P_L}{.035 \times G_H}$ ✓

Gibbs & Hill, Inc.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Date: 11/8/78
Calc By: EHG(1)
Chk'd By: [illegible]
Subject: SP-4 TYPE SUPPORT

Piping Code: SCS-101C
Sheet No.: 3/93
G&H Job No.: 2323-[illegible]
Ref. Dwg. No.: S-0903

CASE 2:



M = .375 P ✓

1	2	3	4	5	6	7	8	9	10	11
G_V	G_H	P_V (KIPS)	P_T (KIPS)	M_x (FT-KIPS)	f_a (KSI)	f_{bx} (KSI)	f_{by} (KSI)	M_Y (FT-KIPS)	P_L (KIPS)	L_{MAX} (FT)
2.40	.57	1.344	.3192	.504	.1499	2.6410	21.8404	.6243	1.6647	41.72
2.50	.80	1.400	.448	.525	.2103	2.7511	21.8263	.6239	1.6636	29.71
2.70	1.25	1.512	.700	.567	.3286	2.9712	21.7960	.6230	1.6613	18.99
2.77	1.72	1.5512	.9632	.5817	.4522	3.0482	21.7831	.6226	1.6604	13.79
2.91	2.25	1.6296	1.260	.6111	.5915	3.2023	21.7577	.6219	1.6584	10.53
.81	2.53	1.5736	1.4168	.5901	.6652	3.0922	21.7714	.6223	1.6595	9.37
2.95	2.83	1.652	1.5848	.6195	.7440	3.2463	21.7465	.6216	1.6576	8.37
2.80	3.20	1.568	1.792	.588	.8413	3.0812	21.7669	.6222	1.6591	7.41

1. G_V 2. G_H 3. $P_V = .035 \times 2. \times 8. \times G_V$ ✓

4. $P_T = .035 \times 2. \times 8. \times G_H$ ✓ 5. $M_x = .375\ P_V$ ✓

6. $f_a = \dfrac{P_T}{2.13}$ ✓ 7. $f_{bx} = \dfrac{M_x \times 12}{2.29}$ ✓

8. $f_{by} = \left[22^2 - f_a^2 - f_{bx}^2\right]^{1/2}$ ✓ 9. $M_Y = \dfrac{f_{by} \times .343}{12}$ ✓

10. $P_L = \dfrac{M_Y}{.375}$ ✓ 11. $L_{MAX} = \dfrac{P_L}{2. \times .035 \times G_H}$ ✓

MEMBER AE OR BD :

CASE 2 CONSIDERED ONLY

$P = \frac{P_V}{2} \times \frac{6''}{8} = \frac{1.652}{2} \times \frac{6}{8} = .6195$ K ✓ (FROM TABLE MAX VALUE)

$P_A = \frac{P_L}{2} = \frac{1.6576}{2} = .8288$ K ✓ $\quad f_a = \frac{.8288}{2.13} = .389$ KSI ✓

$M_{x_1} = .6195 \times 6 = 3.717$ 'K ✓ ~~M .6245 (...)~~

$M_x = [3.717^2 + \sout{.6245}^2]^{\frac{1}{2}} = \sout{3.769}$ 3.717 'K

$f_{b_x} = \frac{\sout{3.769} \; 3.717 \times 12}{2.29} = \sout{19.750}$ 19.48 KSI ✓

$f = [.389^2 + \sout{19.48}\; 19.48^2]^{\frac{1}{2}} = \sout{19.754}$ 19.48 KSI ✓ < 22 OK

BRACE :

FROM TABLE max $P_T = 1.792$ K ✓

$\frac{KL}{r} = \frac{\sqrt{2} \times 6 \times 12}{.587} = 173.5$ ✓ $\quad F_a = 6.77$ KSI ✓

$P = \sqrt{2} \times 1.792 = 2.53$ ✓ $< F_a$

OR

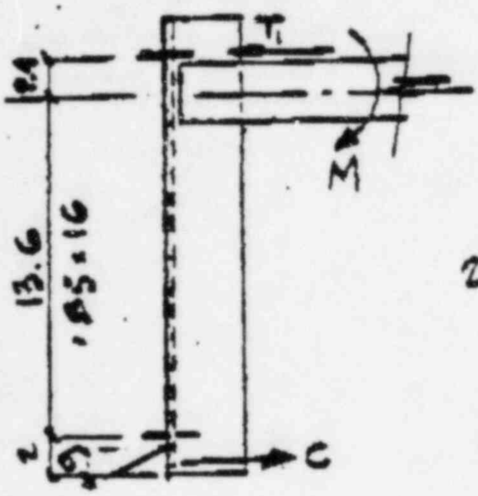
$\frac{KL}{r} = \frac{[6^2 + (\frac{6}{1.5})^2]^{\frac{1}{2}} \times 12}{.587} = 147.4$ ✓ $\quad F_a = 7.96$

$P = [1.792^2 + (1.5 \times 1.792)^2]^{\frac{1}{2}} = 3.23$ K $< F_a$ ✓ OK

BOLTS

BEAM CONNECTION

$M = \text{3.769}$ ~~3.769~~ 3.717 K (SEE PREVIOUS SHEET) (3.769 K used for following calculations)



$T_1 = C = .7 \times 4. \times .5 \times 6 \times a = 8.4a$

$(15.6 - \frac{a}{3}) \times 8.4a + 2.4 \times 8.4a - 3.769 \times 12 = 0$

$2.8a^2 - 151.2a + 45.228 = 0$

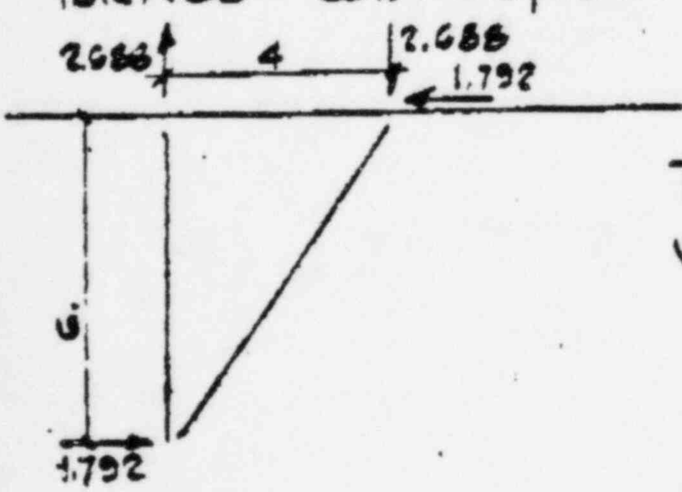
$a = .3008 \qquad T_1 = 2.53\text{ K}$ ✓

$T_2 = \frac{1.6576 \times 13.6}{16.} = 1.41\text{ K}$

$T_3 = \frac{2.688 \times 13.6}{16.} = 2.28$ (SEE BELOW) $\quad T = [2.53^2 + 1.41^2 + 2.28^2]^{\frac{1}{2}} = 3.691$

$V = \frac{3.769}{6 \times 2} = .314\text{ K}$ LOW STRESSES ✓

BRACE CONNECTION



$T = 2.69\text{ K}$

$V = 1.79\text{ K}$

LOW STRESSES ✓

Rec'd 9/26/84 PROJECT FILE BHW

Distribution

R. Hess
J. P. Foley
P. Rainey
N. Williams
84056 PF

TEXAS UTILITIES GENERATING COMPANY
P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

September 2?, 1984

Cygna Energy Services
101 California Street
Suite 1000
San Francisco, California 94111

Attn: Ms. Nancy Williams, Project Manager

COMANCHE PEAK STEAM ELECTRIC STATION
CYGNA REVIEW QUESTIONS

REF: 1) CYGNA LETTER 84056.023 DATED August 21, 1984

Dear Ms. Williams:

Attached is TUGCO's response to the following:

1. Question 3 (Clarification) Reference 1

If there are any further questions or comments, please contact Ms. Jeanne J. Van Amerongen (Extension 500).

Very truly yours,

L. M. Popplewell
Project Engineering Manager

LMP/JVA/bh

cc: L. Popplewell
D.H. Wade
R.E. Ballard
C. Moehlman
J. Van Amerongen

CYGNA	
JOB NO:	84056
DATE LOGGED:	9/26/84
LOG NO.:	#30
FILE:	2.1.1 MC. CR
CROSS REF. FILE	2.1 MC. CR Log

CYGNA QUESTION:

Clarification to Question Number 3

What procedure is used to ensure that the operating modifications made to the "PIPEFLOW" calculation will be utilized?

TUGCO RESPONSE:

Refer to the attached letter CPPA-41,023, CCW System Flow to Ventilation Chillers, which requests that an additional step be added to operating and test procedures to adjust the flow to the non-safety ventilation chillers.

CPPA-41,023

TEXAS UTILITIES SERVICES INC.

OFFICE MEMORANDUM

To R.E. Camp Glen Rose, Texas September 24, 1984

Subject COMANCHE PEAK STEAM ELECTRIC STATION
CCW SYSTEM FLOW
TO VENTILATION CHILLERS

This letter is the completion of the TUGCO response to CYGNA question three (3) concerning failure of the non-safety ventilation chillers during a seismic event. CYGNA postulated a leakage rate in excess of 10,000 gpm from a failure of any one of the chillers.

The TUGCO response to this question is to provide a method of limiting flow to all chillers to a maximum of 2000 gpm (rated flow). These chillers are operated in series and the current method of obtaining rated flow is to throttle valve XCC-95 (located downstream of all four chillers on the discharge line). Please add a step in the operating and test procedures to throttle the inlet valve to each chiller so as to obtain a maximum flow of 2000 gpm to each chiller. The affected valves are XCC-80, XCC-84, XCC-90 and XCC-93.

Restricting the leakage rate from the system by this method will allow the system isolation valves sufficient time to close without enough leakage from the system to adversely affect the CCW pumps.

CKM JKS GES

LMP:CKM:JKS:GES:tw

L.M. Popplewell
CPPE Engineering Manager

CC: ARMS
R.A. Jones
R.G. Cockrel
J. VanAmerongen

BRJ #1699

PROJECT FILE
NOTED OCT 01 1984 N.WILLIAMS

TEXAS UTILITIES GENERATING COMPANY

P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

Distribution
J. Russ/W. Horstman
84056 PF
N. Williams

September 28, 1984

Cygna Energy Services
101 California Street
Suite 1000
San Francisco, California 94111

Attn: Ms. Nancy Williams, Project Manager

COMANCHE PEAK STEAM ELECTRIC STATION
CYGNA REVIEW QUESTIONS

REF: 1) CYGNA LETTER 84056.031 DATED August 31, 1984

Dear Ms. Williams:

Attached is TUGCO's response to the following:

1. Question 2 Reference 1

If there are any further questions or comments, please contact Ms. Jeanne J. Van Amerongen (Extension 500).

Very truly yours,

L. M. Popplewell
Project Engineering Manager

LMP/JVA/bh

cc: L. Popplewell
D.H. Wade
R.E. Ballard
R. Hooton
T. Keiss
J. Van Amerongen

CYGNA	
JOB NO:	84056
DATE LOGGED:	10/1/84
LOG NO.:	#31
FILE:	2.1.1 Inc. CR
CROSS REF. FILE	2.1 Inc. CR Log

CYGNA QUESTION:

2. Eccentric Loads and Connections

2.1 Cable trays are attached to supports by friction type or heavy-duty tray clamps. The former type resists transverse and vertical loads while the later resists transverse, vertical and longitudinal loads. The connection details for these clamps require that they be bolted or welded to the top of the cable tray support beam. A typical connection is shown in Figure 2A. Such connections provide a load transfer which is eccentric to the major axis and to the shear center of the channel sections typically used in the cable tray support designs. As a result, several effects are not considered in the design of the supports.

2.1.1 Major and Minor Axes Flexure

As noted in Figure 2B, the location of the transverse load, P_h, is eccentric to the major axis by a distance d/2, where d is the channel depth. The effect of this eccentricity is an increase in major axis bending. Minor axis bending will occur because P_h is eccentric to the minor axis by a distance of (g-x) where g is the gage distance and x is the location of the neutral axis relative to the back of the channel web.

2.1.2 Torsion due to Vertical Loads

As shown in Figure 2C, vertical cable tray loads are applied eccentrically to the shear center of the channel section which induces torsional moments into the beam. Cygna has noted that only beam members for Regular Case cable tray supports Details A_i, B_i and C_i and Detail SP-7 with brace have been analyzed for the effects of eccentrically applied vertical loads. Cygna is currently reviewing these calculations. No other cable tray supports have been analyzed for the effects of torsion due to vertical loads.

2.1.3 Torsion Due to Longitudinal Loads

As shown in Figure 2C, longitudinal cable tray loads are applied eccentrically to the major axis (X-X) of the channel section which induces torsional moments into the beam member. Cygna has noted that only Detail SP-7 with brace has been analyzed for the effects of eccentrically applied loads.

CYGNA QUESTION: (cont.)

2.2 Eccentric Connections

The cable tray supports are primarily constructed of channel sections for the hanger and beam members and angles for bracing members. (For Cygna's concerns regarding angles, reference Cygna's letter 84056.027, question 2.) Figure 2D shows the eccentricity between the neutral axis of a typical beam and hanger connection. Cygna has noted that the effect of this joint eccentricity has not been considered in the design calculations.

Please provide Cygna with documentation showing the cable tray supports are capable of resisting the applied loads when the effects of the eccentricities described above are considered.

TUGCO RESPONSE:

Calculations SCS-101C Set 1 and Set 3 (attached) provide justification of the acceptability of not considering several effects in the design of the cable tray supports due to an eccentric load transfer.

Gibbs & Hill, Inc.

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A Dravo Company

ST-5477 - SCCh-138

GTN-

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George
Vice President/Project Gen. Manager

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
G&H PROJECT NO. 2323
CABLE TRAY SUPPORTS - CYGNA PHASE 4 AUDIT ACTIVITIES
REF: 1) CYGNA LTR. 84056.31
2) GTN-69484

By copy of this letter to Nancy Williams of CYGNA, attached please find the following calculations in response to question 2 identified in the above reference 1 and the additional calculation for tray support case D1:

1. Question 2.1.1: SCS-101C, Set 1, Revision 4
2. Question 2.1.2: SCS-101C, Set 1, Revision 4
3. Question 2.1.3: SCS-101C, Set 3, Revision 9
4. Question 2.2: SCS-101C, Set 1, Revision 4
5. Case D1: SCS-101C, Set 3, Revision 9

Please note that this letter plus referenced #2 above complete our response to reference #1.

Very truly yours,

GIBBS & HILL, INC.

Robert E. Ballard, Jr.
Director of Projects

REBa-ELB-PTH-SCCh:sce
1 Letter

cc: ARMS (B&R Site) OL
D. Wade (TUSI Site) 1L, 1A
G. Grace (TUSI Site) 1L
C.R. Hooton (TUSI Site) 1L, 1A
N. Williams (CYGNA Ca) 1L, 1A

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS: RESPONSE TO CYGNA'S PHASE IV REVIEW

Calculation Number SCS - 101C Set 1 Sheet No. 147

	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Revision	X	X	1	X		X		X		X	
Checking Method #	X	X	V. PALMIERI	9-7-84							
Preparer	X	X	NV	9.17.84							
Checker	X	X									

Question 2.1.1 Major and Minor Axes Flexure
(CYGNA Letter # 84056.031 DATED AUGUST 31, 1984)

Purpose of Calculation - To provide justification for neglecting the effects of eccentric transverse loading on beam channel sections typically used in the cable tray support designs.

REFERENCES -

(1.) SCS-111C Set 8
(2.) Letter # 84056.031 DATED AUGUST 31, 1984 from CYGNA TO Mr. J.B. George of TUGCO
(3.) AISC MANUAL OF STEEL CONSTRUCTION 7th Ed.
(4.) G&H DWGS.: (a.) 2323-S-0901/4
(b.) 2323-S-0902/5
(5.) 'Formulas for Stress and Strain' 5th Ed. by Roark
(6.) SCS-101C Set 1
(7.) DMI-11C Set 3

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS: RESPONSE TO CYGNA'S PHASE IV REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 148

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			[illegible]	9-7-84						
Checker			L. Palmier	9-25-84						

Question 2.1.1 (con't)

Justification:

Stresses due to the eccentricity of the transverse loads are generally small and therefore neglected in engineering practice for the design of structural frames. The cable tray raceway system including the cable tray and its supports can be considered as a space frame. The additional stresses due to the eccentric transverse loads are found to be small compared to the stresses caused by the primary transverse loads and can be neglected, see sh 162 & 163 R4.

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

Subject CABLE TRAY SUPPORTS : RESPONSE TO CYGNA'S PHASE IV REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 149

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	X	X	1	X		X		X		X	
Preparer	X	X	L. Palmieri	9-7-84							
Checker	X	X	NV	9.17.84							

Question 2.1.1 (cont)

The following calculations demonstrate the acceptability of neglecting the eccentric loadings on the beam channel sections typically used in the cable tray support designs.

1) Major axis bending due to eccentricity of transverse load:

X-X - major axis

Y-Y - minor or weak axis

C4 x 7.25 BEAM

$g = 1''$

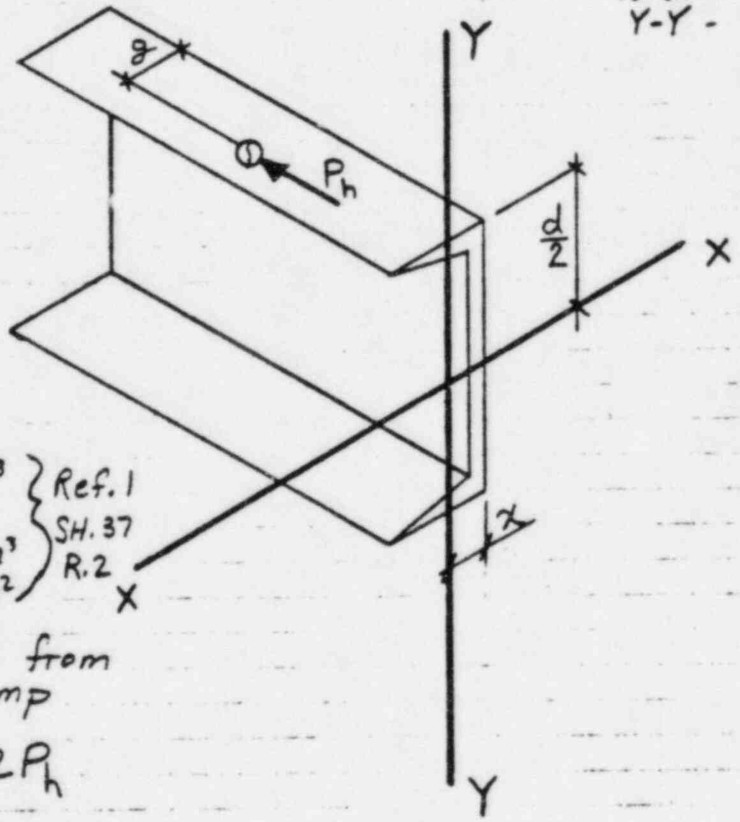
$d/2 = 2''$

$x = .459''$

$S_{x\text{-}x} = 2.29\ in^3$

$S_{y\text{-}y} = 0.343\ in^3$

Reduced $S_{x\text{-}x} = 1.948\ in^3$
Reduced $S_{y\text{-}y} = 0.297\ in^3$
Reduced Area $= 2.003\ in^2$
} Ref. 1 SH. 37 R.2



P_h = transverse load from cable tray clamp

$M_{XX} = P_h \times \frac{d}{2} = 2P_h$

$M_{YY} = P_h \times (g - x) = 0.541 P_h$

$P_h = \frac{3.33^k}{4} = 0.832$ k/bolt (4 cable tray clamp bolts)
[See Ref. 1 SH. 32 R.1 for $P_a^T = 3.33^k$]

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

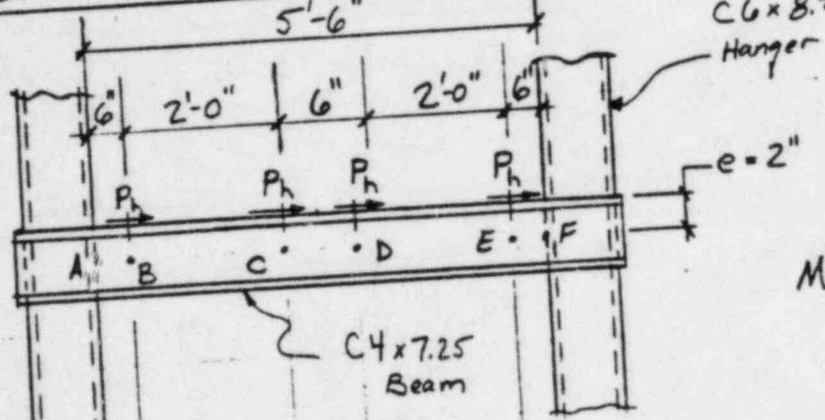
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA'S PHASE IV REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 150

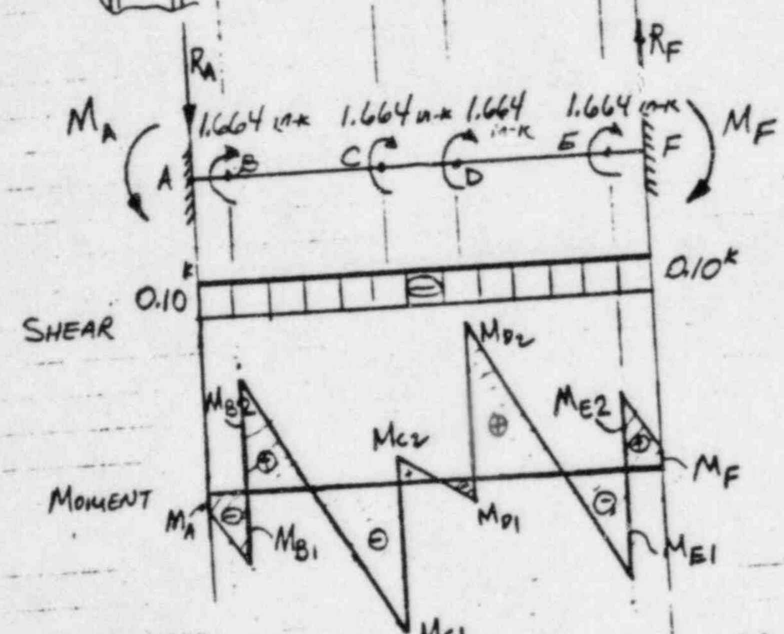
	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Revision			1							
Checking Method #										
Preparer			K. PALMIERI	9-7-84						
Checker			NV	9.17.84						

Question 2.1.1 (cont)

i) Cases A_i, B_i & C_i ($i = 1$ to 4)



$M_{xx} = 2P_h = 2(.832) = 1.664$ in-k



SEE REFER. 5 Page 103

$$M_A = \frac{1.664(60)}{66}\left(1 - \frac{3(6)}{66}\right) + \frac{1.664(36)}{66}\left(1 - \frac{3(30)}{66}\right) + \frac{1.664(30)}{66}\left(1 - \frac{3(36)}{66}\right) + \frac{1.664(6)}{66}\left(1 - \frac{3(60)}{66}\right)$$

$= .0275$ in-k

$M_F = -M_A = -.0275$ in-k

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			K. PALMIERI	9-7-84						
Checker			NV	9.7.84						

Question 2.1.1 (cont)

$$R_A = V = -\frac{6(1.664)(6)(60)}{66^3} - \frac{6(1.664)(30)(36)}{66^3} - \frac{6(1.664)(36)(30)}{66^3} - \frac{6(1.664)(60)(6)}{66^3}$$

$$= -0.10$$

$$R_F = V = -R_A = 0.10$$

$M_{B_1} = -.0275 - 6'(.10) = -0.6275$ in-k

$M_{B_2} = -0.6275 + 1.664 = 1.036$ in-k

$M_{C_1} = 1.036 - 24(.10) = -1.364$ in-k

$M_{C_2} = -1.364 + 1.664 = 0.300$ in-k

$M_{D_1} = 0.300 - 6(.10) = -0.300$ in-k

$M_{D_2} = -0.300 + 1.664 = 1.364$ in-k

$M_{E_1} = 1.364 - 24(.10) = -1.036$ in-k

$M_{E_2} = -1.036 + 1.664 = 0.6275$ in-k

$M_F = 0.6275 - 6(.10) = 0.0275$ in-k checks

Check additional stresses @ Beam

@ point A (CRITICAL POINT):

$\Delta f^t_{bx_A} = \frac{0.0275}{2.29} = 0.012$ ksi negligible

$\Delta f^t_{bx_A} / F_{bx} = \frac{0.012}{22.} = 0.05\%$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 152

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCCS	9-21-84						
Checker			L. PALMIERI	9-25-84						

Question 2.1.1 (CONT)

@ point B : (Bolt hole location)

$$\Delta f^t_{by_B} = \frac{1.036}{1.948} = 0.532^{ksi}$$

(1.948 ← Sh. 149 R4)

$$\text{or} \quad \frac{\Delta f^t_{by_B}}{F_{bx}} = \frac{0.532}{22.} = 2.42\%$$

<u>additional stresses @ hanger</u> : C6×8.2

$$\Delta P_a = 0.1^K \quad , \Delta f^t_a = \frac{0.1}{2.4} = 0.042^{ksi} \text{ negligible}$$

$$\Delta M = M_A + 0.1 \times 3''$$

$$= 0.0275 + 0.3 = 0.328^{''K}$$

$$\Delta f^t_{bx\,hgr} = \frac{0.328}{4.38} = 0.075^{ksi} \quad \text{negligible}$$

$$\Delta f^t_{bx\,hgr} / F_{bx} = \frac{0.075}{22} = 0.34\%$$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

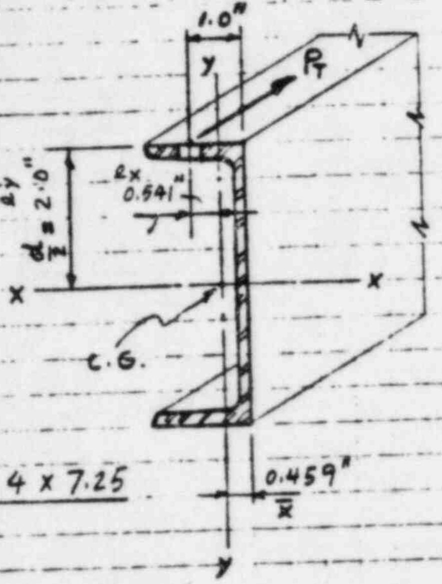
Subject CABLE TRAY SUPPORTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 153

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-12-84						
Checker			SCCS	9.25.84						

– QUESTION 2.1.1 (CONT'D) –

ii) CASES D_i & D_i W/BR (i = 1 TO 4)



C 4 x 7.25

TRANSVERSE SEISMIC (ECCENTRICITY)

$$P^T = 0.035 \times 2' \times 8.5' \times 1.05 \times \frac{1}{2} = 0.3124^K$$

(G_H = 1.05; REF. SCS-101C SET 3 SH. 239 R.9)

$$M_x^T = 0.3124 \times 2'' = 0.6248^{''-K}$$

FIXED END MOMENT: REF "ANALYSIS OF FRAMED STRUTURES" BY GERE & WEAVER ©1965, PG. 453

e_y;
$$M_{xA} = \frac{-0.6248}{8.0^2}\Big[6.25(2\times1.75-6.25) + 4.25(2\times3.75-4.25) + 3.75(2\times4.25-3.75) + 1.75(2\times6.25-1.75)\Big]$$

$$= -0.3245^{''-K}$$

$$M_{xB} = M_{xA} = -0.3245^{''-K}$$

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS — RESPONSE TO CYGNA PHASE 4 REVIEW

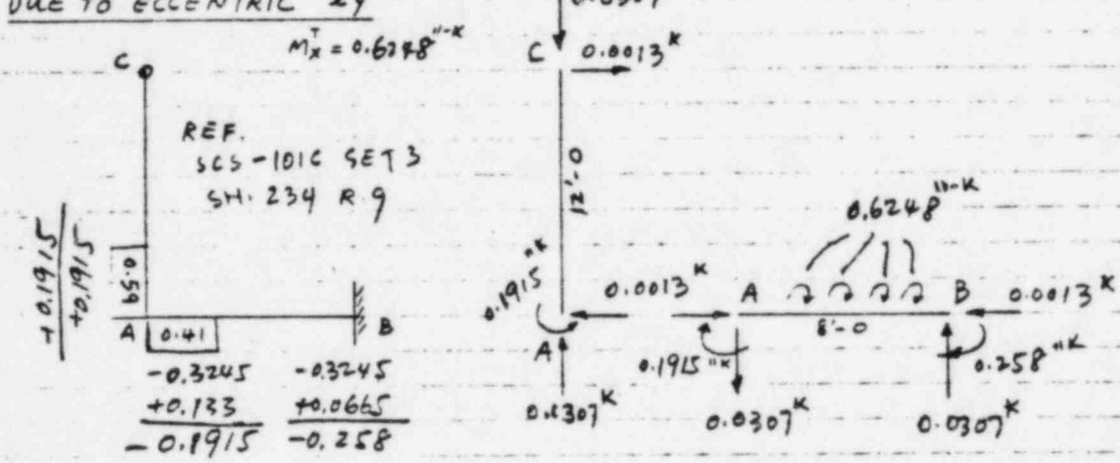
Calculation Number SCS-101C SET 1 Sheet No. 154

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-12-84						
Checker			[illegible]	9-25-84						

QUESTION 2.1.1 (CONT'D)

ii) CASES D_i & D_i W/BR ($i = 1$ TO 4) :

<u>DUE TO ECCENTRIC 'ey'</u>



<u>BEAM</u> @ PT. B; $\Delta f^T_{bx_B} = \frac{0.258}{2.29} = 0.1127^{KSI}$

@ BOLT HOLE LOCATION, NOT CRITICAL SEE SCS-101C SET 3 SH. 242 R.9

<u>HANGER</u> $\Delta f^T_{bxA} = \frac{0.1915}{4.38} = 0.044^{KSI}$ } NEGLIGIBLE

$\Delta f^T_a = \frac{0.0307}{2.4} = 0.0128^{KSI}$

Since the stresses due to the vertical loads are the governing stresses in the design*, the above small stresses due to the transverse load eccentricity have no impact on the support cases D_i and D_i w/ Brace.

* See SCS-101C Set 3 SH. 241-243 R.9

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C set 1 Sheet No. 155

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			Scc	9.21.84							
Checker			L. PALMIERI	9-25-84							

Question 2.1.1 (cont)

iii) CASES SP-7 & SP-7 W/BR : C6×8.2 Bm

TRANSVERSE SEISMIC:

Ref. to SCS-101C set 3 sh 236 to 239 R9

$$f_{ext} = \frac{1}{\sqrt{\frac{1}{f_t^2} + \frac{1}{f_c^2}}} = \frac{1}{\sqrt{\frac{1}{77.3^2} + \frac{1}{18.97^2}}} = 18.42 \text{ hz} \Rightarrow g_h = 1.1415$$

$$f_{int} = \frac{1}{\sqrt{\frac{1}{77.3^2} + \frac{1}{29.6^2}}} = 27.64 \text{ hz} \Rightarrow g_h = 0.6562$$

Ref. DMI-11C set 3 Sh 19 R0

$$g_{avg} = \tfrac{1}{2}(1.1415 + 0.6562) = 0.899$$

USE $g_h = 1.0$

$$P^t = 0.035 \times 2.5 \times 8.5 \times 1 = 0.744^k$$

$$\Delta M_x^t = 0.744 \times 3'' = 2.232^{''k}$$

$$\Delta f_{bx}^t = \frac{2.232}{4.38} = 0.51^{ksi} \; ; \quad \frac{\Delta f_{bx}^t}{F_{bx}} = \frac{0.51}{22} = 2.32\%$$

Small

The above small stress, 0.51^{ksi}, due to eccentricity of the transverse load has no impact on case SP-7 since the stresses due to vertical loads are the governing stresses in the design.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

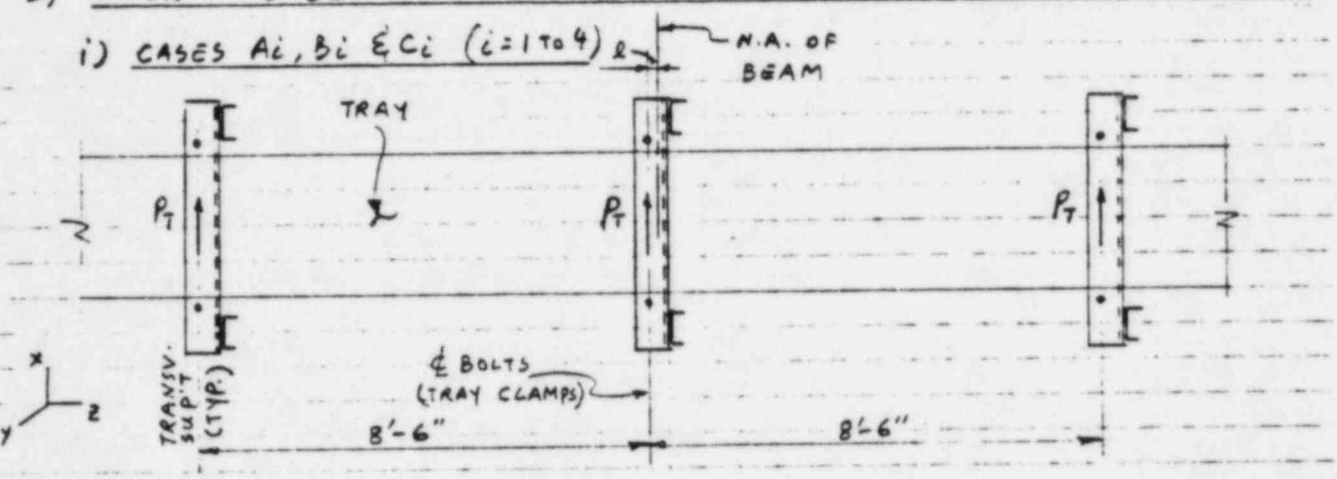
Calculation Number SCS-101C SET 1 | Sheet No. 156

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-14-84						
Checker			Secs	9-25-84						

QUES. 2.1.1 (CONT'D)

2) MINOR AXIS BENDING DUE TO ECCENTRICITY OF TRANSVERSE LOAD

i) CASES Ai, Bi & Ci (i=1 TO 4)



BENDING MOMENT ABOUT MINOR AXIS DUE TO ECCENTRICITY 'ℓ', $M_y = P_T \times \ell$ WILL INDUCE A COUPLE BETWEEN TWO ADJACENT TRAY SUPPORTS. The tray and the support will act as a system and since the tray is stiff in the transverse direction, the coupling forces will be transmitted to the supports.

STIFFNESS: $K_{TRAY} = \frac{4.13}{8.5'} = 0.486$ (24" TRAY $I_{yy} = 4.13\ in^4$ SEE SCS-101C SET 5 SH. 30 R.3)

BEAM C4×7.25

$K_{BM} = \frac{0.433}{3.0'} = 0.144$

$\frac{K_{TRAY}}{K_{BM}} = \frac{0.486}{0.144} = 3.375$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 157

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			[illegible]	9.21.84						
Checker			L. PALMIERI	9-25-84						

- Question 2.1.1 (cont)

ii) Cases D_i & D_i W/BR (i = 1 to 4)

PLAN

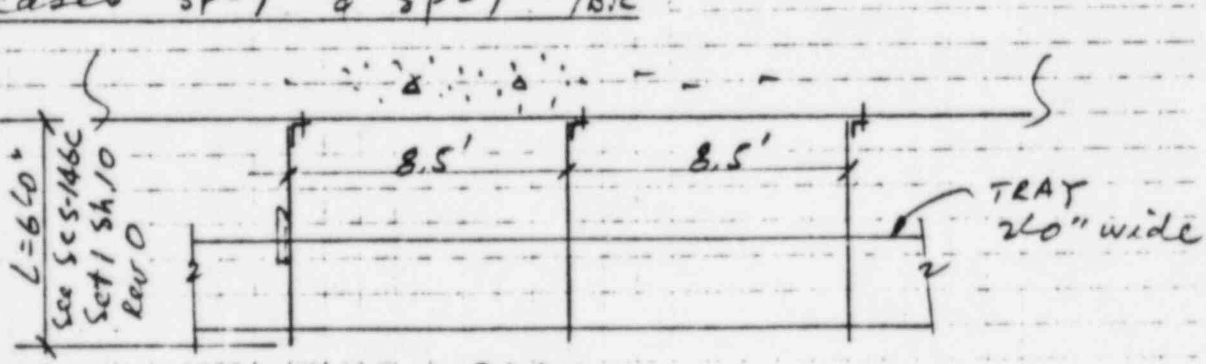
STIFFNESS:

$$K_{tray} = \frac{2 \times 4.13}{8.5} = 0.972$$

$$K_{Beam} = \frac{0.433}{8.0} = 0.054$$

$$\frac{K_{tray}}{K_{Beam}} = \frac{0.972}{0.054} = \frac{18}{1}$$

iii) Cases SP-7 & SP-7 W/BR



PLAN

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C set 1 Sheet No. 158

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SCCS	9-21-84							
Checker			L. PALMIERI	9-25-84							

Question 2.1.1 (cont)

$$K_{tray} = \frac{4.13}{8.5} = 0.486$$

$$K_{Beam} = \frac{0.693}{6.0} = 0.1155$$

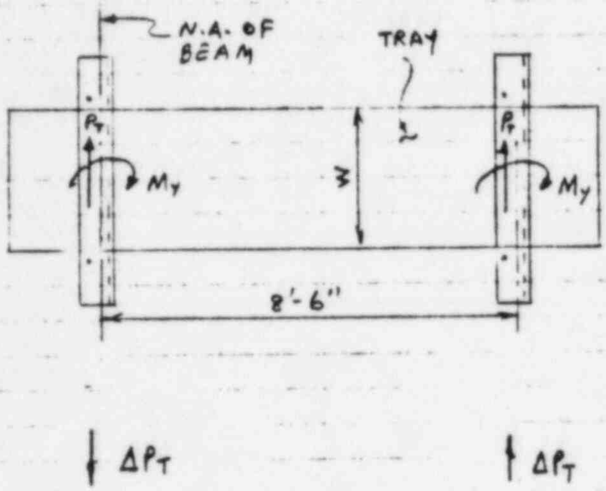
$$\frac{K_{tray}}{K_{beam}} = \frac{0.486}{0.1155} = 4.21$$

The above calculations indicate that the tray is much stiffer in the transverse direction than the beam in resisting the weak axis bending due to the transverse load eccentricity. Therefore, the tray is transforming the weak axis bending into a coupling force (ΔP_T) to the two adjacent supports. The effect of these coupling forces will be evaluated as follows:

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 1		Sheet No. 159

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			MC	9-14-84						
Checker			[illegible]	9-25-84						

QUES. 2.1.1 (CONT'D)



ECCENTRIC MOMENT M_Y WILL INDUCE ADDITIONAL TRANSVERSE FORCE ΔP_T TO THE BEAM.

$P_T = 35 \times W \times 8.5' \times G_H = 8.5K$ #

$(K = 35 \times W \times G_H)$

e = ECCENTRICITY, IN.

ADDITIONAL TRANSV. FORCE, ΔP_T

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 1		Sheet No. 160

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-14-84						
Checker			SCCS	9-15-84						

QUES. 2.1.1 (CONT'D)

$$M = 8.5K \times \frac{2''}{12} = 0.7083 K\text{-}{}'{}^{\#}$$

$\frac{6.25}{8.5} M = 0.74 M$

DIST. FACTOR	1.0	3/7	4/7	0.5	0.5	0.5	0.5	0.5	0.5
+0.74 M	-0.740	-0.429	-0.571	+0.5	+0.5	-0.5	-0.5	+0.5	+0.5
		-0.370	+0.250	-0.286	-0.25	+0.25	+0.25	-0.25	-0.25
		+0.051	+0.069	+0.268	+0.268	-0.25	-0.25	+0.25	+0.25
			+0.134	+0.035	-0.125	+0.134	+0.125	-0.125	-0.125
		-0.057	-0.077	+0.045	+0.045	-0.1295	-0.1295	+0.125	+0.125
			+0.023	-0.039	-0.065	+0.023	+0.063	-0.063	-0.063
		-0.010	-0.013	+0.052	+0.052	-0.043	-0.043	+0.064	+0.064
			+0.026	-0.007	-0.021	+0.026	+0.032	-0.022	-0.032
		-0.011	-0.015	+0.014	+0.014	-0.029	-0.029	+0.027	+0.027
+0.74	-0.74	-0.826	-0.174	+0.582	+0.418	-0.5185	-0.4815	+0.504	+0.496
SHEAR	↓0.1842M	0.1842M↑	↑0.048M	0.048M↓					
REACTION		0.2322M↑							

Checking Method # 1. Line-by-line checking 2. Alternative Calculation Results compared 3. Identical Calculation Results compared 4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 161

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-14-84						
Checker			[illegible]	9-25-84						

QUES. 2.1.1 (CONT'D)

Critical Location

SUP'T @ ②: $P_T = 8.5K$

$$\frac{\Delta P_T}{P_T} = \frac{0.2322 \times 0.7083\,K\ell}{8.5K} = 0.0193\,\ell \leftarrow \text{GOVERNS}$$

BEAM C4×7.25, GAGE $g = 1.0''$ $\bar{x} = 0.459''$

$$\ell = 1.0 - 0.459 = 0.541''$$

$$\frac{\Delta P_T}{P_T} = 0.0193 \times 0.541 = 0.0104 = 1.04\,\%$$

THE ABOVE INCREASE IS for the support cases A_i, B_i, & C_i ($i = 1$ to 4) and is insignificant. IT HAS NO IMPACT ON THE SUP'T CASES D_i & D_i W/BR. (i = 1 TO 4), SP-7 & SP-7 W/BR SINCE THE STRESSES DUE TO VERTICAL LOADS are the governing stresses in the design.

TRAY @ ②:

$$\Delta M_y^T = 0.826M = 0.826 \times (0.7083\,K\ell) = 0.5851\,K\ell \quad 1\#$$

$$M_y^T = \frac{1}{10} \times (8.5K) \times 8.5 = 7.225K \quad 7\#$$

$$\frac{\Delta M_y^T}{M_y^T} = \frac{0.5851\,K\ell}{7.225K} = 0.081\,\ell$$

$$= 0.081 \times 0.541 = 0.0438 = 4.38\,\%$$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 162

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Sccb	9.21.84						
Checker			L. PALMIERI	9-25-84						

Question 2.1.1 (cont)

SUMMARY & CONCLUSION:

EFFECT OF MAJOR AXIS BENDING DUE TO ECCENTRICITY OF TRANSVERSE LOADS

$$F_{bx} = 22.^{ksi}$$

SUPPORT CASE $i = 1$ to 4	HANGER		BEAM				REMARKS
			@ END		@ BOLT HOLE		
	Δf_{bx} ksi	$\Delta f_{bx}/F_{bx}$	Δf_{bx} ksi	$\Delta f_{bx}/F_{bx}$	Δf_{bx} ksi	$\Delta f_{bx}/F_{bx}$	
A_i, B_i, C_i	0.075	0.34%	0.012	0.05%	0.532	2.42%	1. EFFECT IS NEGLIGIBLE 2. STRESSES ON BEAM @ BOLT HOLE LOCATION ARE NOT CRITICAL - SEE SH. 182 R4
D_i, D_i w/BR	0.042	0.2%	0.107	0.49%	*	*	NO EFFECT ON MEMBERS, SINCE ADDITIONAL STRESS DUE TO ECCENTRICITY OF TRANSVERSE LOAD IS SMALL AND VERTICAL LOADS GOVERN
SP-7, SP-7 w/BR	-	-	0.51	2.32%	*	*	
L-A_i, L-B_i, L-C_i	-	-	-	-	-	-	

*: STRESSES @ BOLT HOLE LOCATION OF BEAM ARE NOT CRITICAL.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 163

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SCCh	9.21.84						
Checker			I. PALMIERI	9-25-84						

Question 2.1.1 (cont)

Summary:

EFFECT OF MINOR AXIS BENDING

DUE TO ECCENTRICITY OF TRANSVERSE LOADS

P_T: TRANSVERSE LOADS

SUPPORT CASE $i=1$ to 4	$\Delta P_T / P_T$ HANGER	BEAM	TRAY	REMARKS
A_i, B_i, C_i	1.04%	1.04%	* 4.38%	IMPACT ON MEMBERS DUE TO STRESS INCREASE IS INSIGNIFICANT
D_i, D_i W/BR	1.04%	1.04%	* 4.38%	NO IMPACT ON MEMBERS, SINCE ADD'L TRANSVERSE LOAD IS SMALL AND VERTICAL LOADS GOVERN
SP-7, SP-7 W/BR	–			
L-A_i, L-B_i, L-C_i	–	–	–	

*: FURTHER VERIFICATION FOR TRAYS SEE SH. 179 & 180

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 164

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Seeh	9.12.84						
Checker			MC	9.26.84						

Question 2.1.2: (CYGNA LTR 84056.031 ATTACHMENT A)
TORSION due to Vertical loads

Purpose: To evaluate the torsion effects on the cable tray support beams due to vertical cable tray loads.

References:

1. LETTER 84056.031 FROM CYGNA TO Mr. J. B. GEORGE of TUGCO dated Aug. 31, 1984, attachment A item 2.1.2
2. DWG. 2323-S-0901/4
3. DWG. 2323-S-0902/5
4. DWG. 2323-S-0903/5
5. BK. SCS-101C SET 1
6. BK. SCS-101C SET 2
7. BK. SCS-101C SET 3
8. "TORSION ANALYSIS OF ROLLED STEEL SECTIONS" DESIGN DATA FROM BETHLEHEM STEEL

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY Sup'ts - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C set 1		Sheet No. 165

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Secl	9-19-84						
Checker			mc	9-26-84						

Question 2.1.2 (cont)

Justification:

Torsional stresses caused by loads acting in the plane of the minor axis of a channel member are generally neglected in engineering practice if the support arrangement is symmetrical about the center line of the system as illustrated below:

SECT.

The cable tray and the support are treated as a system. The capability of the cable tray to resist the bending due to vertical loads is much greater than the beams capability in resisting torsion. Consequently the cable tray is actually resisting the entire

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 166

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SCCS	9.19.84							
Checker			MC	9.26.84							

Question 2.1.2 (cont)

torsional effects due to the vertical loads.

The effects of torsion due to the vertical loads are found to be minor and can be neglected. See sh. 174 R4

The following calculations demonstrate the acceptability of the original assumption of neglecting the torsional effects due to the vertical loads and the adequacy of the tray supports.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

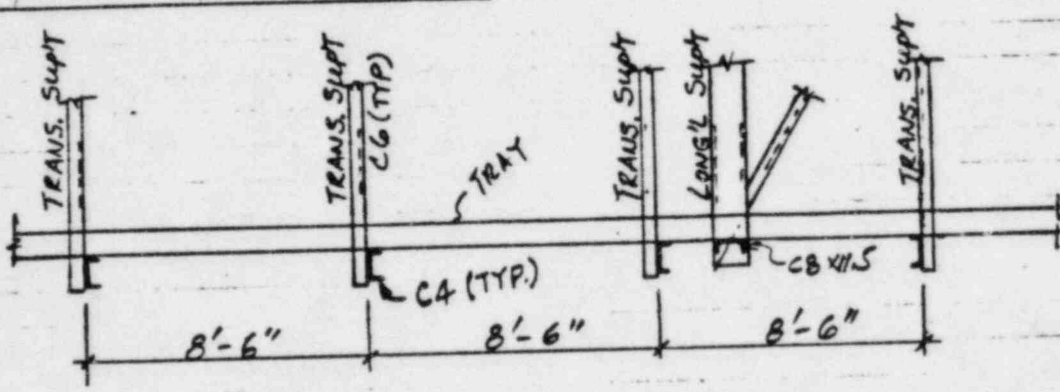
Calculation Number SCS-101C SET 1 Sheet No. 167

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCCB	9-13-84						
Checker			MC	9-26-84						

Question 2.1.2 (cont)

1) TRANSVERSE SUPPORTS:

STIFFNESS OF MEMBERS:



ELEVATION

CABLE TRAY: 2'-0" WIDE , $I_{xx} = 2.46$ IN^4
(REF. SCS-101C, SET 5, Sh 30 R3)

$$\Sigma K_t = 2\left(\frac{3EI_x}{l}\right) = \frac{6 \times 29 \times 10^3 \times 2.46}{8.5 \times 12} = 4.2 \times 10^3 \text{ "K}$$

(conservative)

BEAM C4 x 7.25 : $J = 0.082$ IN^4 (torsional constant) Ref. 8
$a = 6.25"$, $L/a = \frac{3 \times 12}{6.25} = 5.76$

case 6 : (conservative)

$z/L = 0.5$, $\phi\left(\frac{GJ}{M} \cdot \frac{1}{a}\right) \cong 0.544$

$$K_B = \frac{M}{\phi} = \frac{GJ}{0.544a} = \frac{11.2 \times 10^3 \times 0.082}{0.544 \times 6.25} = 0.27 \times 10^3 \text{ "K}$$

$$\frac{\Sigma K_{cable\ tray}}{K_{beam}} = \frac{4.2 \times 10^3}{0.27 \times 10^3} = \frac{15.6}{1}$$

The above stiffness ratio indicates

Checking Method # 1. Line-by-line checking 2. Alternative Calculation Results compared 3. Identical Calculation Results compared 4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO

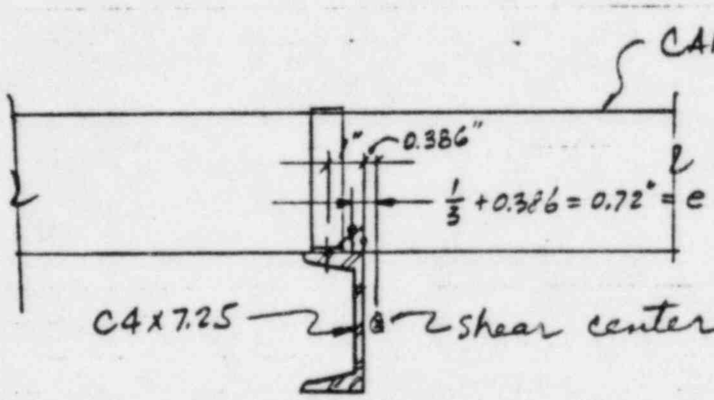
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 168

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			Scch	9/19/84							
Checker			WC	9-26-84							

Question 2.1.2 (cont)

that the cable tray stiffness is much greater than the beam stiffness. The cable tray is actually resisting the entire torsional effects due to the vertical loads.



SECTION

$$P_{D.L.} = 0.035 \times 2 \times 8.5 = 0.595\ ^{K}/_{Tray}$$

$$\Delta M_{D.L.} = P_{D.L.} \times e = 0.595 \times 0.72 = 0.428\ ^{\prime\prime K}$$

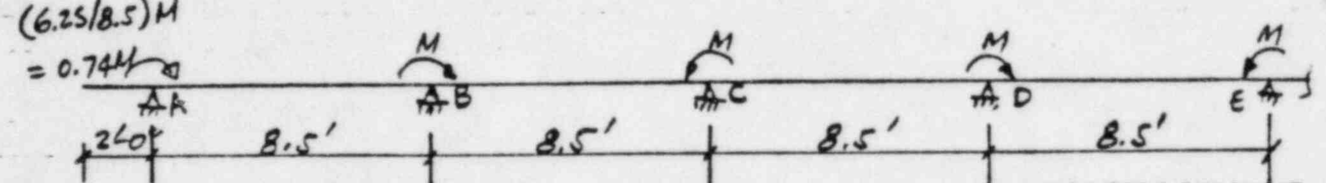
$$\Delta M_{T} = 1.67\ (\Delta M_{D.L.}) = 0.715\ ^{\prime\prime K}$$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUP'TS – RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 1		Sheet No. 169

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			secb	9.15.84							
Checker			MC	9-26.84							

Question 2.1.2 (cont)



	A	B (left)	B (right)	C (left)	C (right)	D (left)	D (right)	E (left)	E (right)
	1.0	3/7	4/7	0.5	0.5	0.5	0.5	0.5	0.5
+0.74	-0.74	-0.429	-0.571	+0.5	+0.5	-0.5	-0.5	+0.5	+0.5
		-0.37	+0.25	-0.286	-0.25	+0.25	+0.25	-0.25	-0.25
		+0.051	+0.069	+0.268	+0.268	-0.25	-0.25	+0.25	+0.25
			+0.134	+0.035	-0.125	+0.134	+0.125	-0.125	-0.125
		-0.057	-0.077	+0.045	+0.045	-0.130	-0.130	+0.125	+0.125
			+0.023	-0.039	-0.065	+0.023	+0.063	-0.063	-0.063
		-0.010	-0.013	+0.052	+0.052	-0.043	-0.043	+0.063	+0.063
			+0.026	-0.007	-0.021	+0.026	+0.032	-0.021	-0.021
		-0.011	-0.015	+0.014	+0.014	-0.029	-0.029	+0.021	+0.021
+0.74	-0.74	-0.826	-0.174	+0.582	+0.418	-0.519	-0.482	+0.50	+0.50

Shear ↓0.1842M .1842M↑ ↑0.048M 0.048M↓

REACTION

↑ 0.2322M , M = [1K]

Sup'T @ B : $\Delta P_{O.L.} = 0.2322 \times \Delta M_{O.L.} = 0.2322 \times 0.428/12 = 0.00828^{K}$

$$\frac{\Delta P_{O.L.}}{P_{O.L.}} = \frac{0.00828}{0.595} = 1.39\,\%$$

The 1.39% increase of the vertical loads has practically no impact on support CASES A_i, B_i & C_i ($i = 1$ to 4)

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY Supts - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 170

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			[illegible]	9-20-84						
Checker			VJC	9-26-84						

Question 2.1.2 (cont)

since the transverse loads are the governing loads in the design. Note that the torsional stresses due to vertical loads have been conservatively considered in the design of cases A_i, B_i & C_i ($i = 1$ to 4) in 1982 (see SCS-111C SET 8, sh 28 to 33R1, sh 34 to 39R2) and were found to be acceptable.

Support cases SP-7 & SP-7 W/BR were originally designed for $G_v = 2.67$ which is 2.7% greater than the actual $G_v = 1.0 + 1.6 = 2.60$ (see sh. 172R4). This 2.7% margin is greater than the 1.39% increase by the torsional stresses due to the vertical loads. Therefore, the supports SP-7 & SP-7 W/BR are adequate.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 171

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			Seck	9-20-84							
Checker			MC	9-26-84							

Question 2.1.2 (cont)

Check TRAY

Tray @ B:

$$\Delta M_{x\,D.L.} = 0.826M = 0.826(0.428) = 0.354^{\,\prime K}$$

$$M_{x\,D.L.} = \frac{1}{10}(0.035 \times 2)(8.5)^2 \times 1.2 = 6.07^{\,\prime K}$$

$$\frac{\Delta M_{x\,D.L.}}{M_{x\,D.L.}} = \frac{0.354}{6.07} = 5.83\%$$

The 5.83% increase of the vertical loads will be resisted by the tray.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

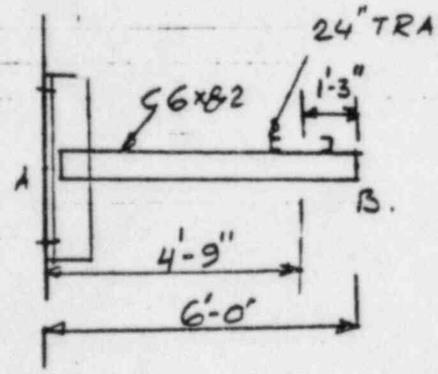
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA'S PHASE IV REVIEW.

Calculation Number SCS 101C SET 1 Sheet No. 172

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			DMG.	9.16.84							
Checker			NV	9.17.84							

Question 2.1.2 (cont)

CASE SP 7 : To find the frequency of the tray & support



$P_{D.L.\ tray} = 2 \times 35 \times 8.5 = 595^{\#}$

$P_{D.L.\ Beam} = 8.2 \times 6 = 49.2^{\#}$

$\Sigma P_{D.L.} = 644.2^{\#}$

$$\Delta_{CB} = \frac{49.2 \times 72^3}{8 \times 29 \times 10^6 \times 13.1} + \frac{595 \times 57^3}{3 \times 29 \times 10^6 \times 13.1}\left(1 + \frac{3 \times 15}{2 \times 57}\right)$$

$$= 140890 \times 10^{-6}$$

$$k = \frac{1}{\Delta} = \frac{644.2}{140890 \times 10^{-6}} = 4.6 \times 10^3 \ \#/in$$

$$f_{sup't} = \frac{1}{2\pi}\sqrt{\frac{4.6 \times 386.4}{644.2}} = 8.36 \text{ hz}$$

CABLE TRAY : $I_x = 2.46 \text{ IN}^4$ (Ref. SCS-101C SET 5 sh 30 R3)

Ref. to SCS-101C Set 3 sh 237 to 239 R9

exterior span : BY PROPORTION

$$f_{ext} = \frac{1}{2\pi}\sqrt{\left(\frac{2.46}{4.13}\right)\left(\frac{0.02187 \times 10^6 \times 386.4}{595}\right)} = 14.64 \text{ hz}$$

$$\Sigma f = \frac{1}{\sqrt{\frac{1}{8.36^2} + \frac{1}{14.64^2}}} = 7.26 \text{ hz} \overset{*}{\Rightarrow} g_v = 1.60$$

* Ref. DMI-11C Set 3 sh 18 R0

Interior span :

$$f_{int.} = \frac{1}{2\pi}\sqrt{\left(\frac{2.46}{4.13}\right)\left(\frac{0.05323 \times 10^6 \times 386.4}{595}\right)} = 22.84 \text{ hz}$$

$$\Sigma f = \frac{1}{\sqrt{\frac{1}{8.36^2} + \frac{1}{22.84^2}}} = 7.85 \text{ hz} \underset{*}{\Rightarrow} g_v = 1.60$$

$\therefore g_v = 1.6$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

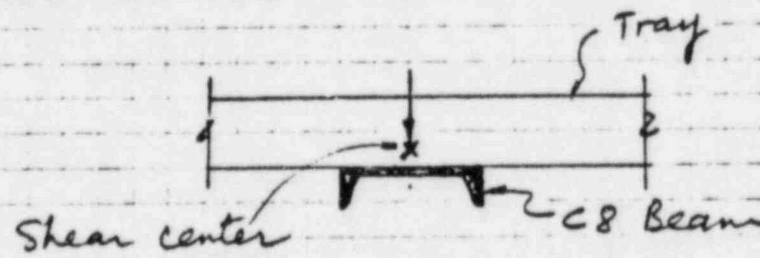
Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C Set 1		Sheet No. 173

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SCCS	9.20.90							
Checker			MC	9.26.90							

Question 2.1.2 (cont)

2) Longitudinal cable tray supports:

Longitudinal cable tray support cases L-A_i, L-B_i & L-C_i (i = 1 to 4) are not designed for the vertical tray loads and the beams are arranged in such a manner to have the vertical member loads passing through the shear center. Therefore, torsional moment does not exist.



SECTION

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 1 Sheet No. 174

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			Scch	9-21-84							
Checker			WC	9-26-84							

Question 2.1.2 (cont)

SUMMARY & CONCLUSION:

TORSIONAL EFFECT DUE TO VERTICAL LOADS

P_v : Vertical loads

SUPPORT CASE $i = 1$ to 4	$\Delta P_v / P_v$			REMARKS
	HANGER	BEAM	TRAY	
A_i, B_i, C_i	1.39%	1.39%	5.83% *	NO EFFECT ON MEMBERS, SINCE ADD'L VERTICAL LOAD IS SMALL AND TRANSVERSE LOAD GOVERNS
SP-7, SP-7 W/BR	1.39%	1.39%	5.83% *	SUPTS ARE O.K.
D_i, D_i W/BR	1.39%	1.39%	5.83% *	IMPACT ON MEMBERS DUE TO STRESS INCREASE IS INSIGNIFICANT
L-A_i, L-B_i, L-C_i	-	-	-	

* FURTHER VERIFICATION FOR TRAYS SEE SH. 179 & 180 R4

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 244

Revision	Original Issue	Date	Rev. 0	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			Seel	5-24-84							
Checker			L. Palmieri	9-25-84							

Question 2.1.3: (CYGNA LTR 84056.031 ATTACHMENT A)
TORSION DUE TO LONGITUDINAL LOADS

Purpose: To provide justification for the longitudinal cable tray support beam to resist the additional torsional effects due to the eccentric longitudinal tray loads.

References:

1). LTR 84056.031 dated 8/31/84 from CYGNA to Mr. J. B. George of TUGCO, item 2.1.3 attachment A.

2) G & H dwg 2323-S-0902/5 & S-0903/5

3) calc. Bk SCS-101C Set 2

Checking Method # 1 Line-by-line checking 2 Alternative Calculation Results compared 3 Identical Calculation Results compared 4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 3		Sheet No. 245

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Scel	9.26.84						
Checker			I.PALMIERI	9-25-84						

Question 2.1.3 (cont)

Justification:

The horizontal earthquake intensities in the longitudinal direction have been recalculated to eliminate the conservatism used in the original design. The longitudinal cable tray supports are classified into three groups as follows:

Group 1 ; L-Ai, L-Bi, L-Ci (i=1 to 4)

Group 2 ; Di W/BR (i=1 to 4)

Group 3 ; SP-7 W/BR

The following calculations demonstrate the adequacy of the beam to resist the additional torsional effects due to the eccentric longitudinal tray loads.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

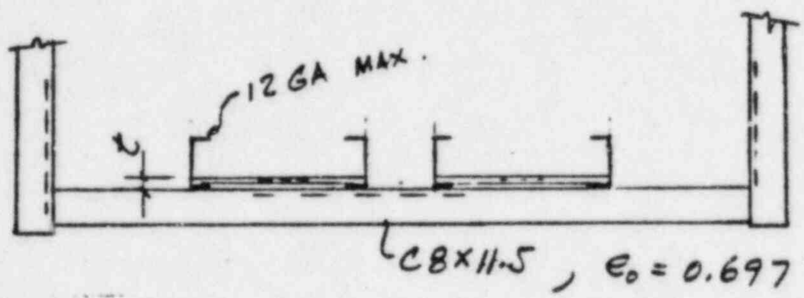
Subject CABLE TRAY Supp'TS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 3 Sheet No. 246

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			Sec cb	9/11/84							
Checker			L. PALMIERI	9-25-84							

Question 2.1.3 (cont)

Group 1: L-A_i, L-B_i & L-C_i, i = 1 to 4



ELEVATION

FOR LADDER TYPE: GG-24SL-12-06

$$t_{max} = 0.1084 + 13/16 = 0.9209''$$

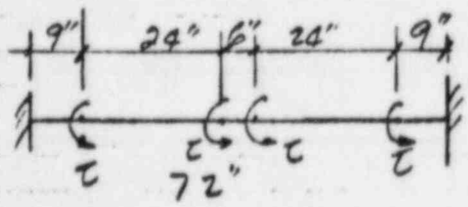
FOR TROF. TYPE: GF-24SL-12-CP

$$t_{max} = 0.1084 + 3/8 + 0.0516 = 0.535''$$ (0.0516: 18 GA. Cst pl)

The tray is treated as an integral part of the beam cf which provides adequate clamp bearing surface. (clamp 4" Lg)

ECCENTRICITY, e = 0.9209 − 0.697 = 0.224" (GOVERN)

or = 0.697 − 0.535 = 0.162"



$$\tau = \frac{7.48}{2} \times 0.224'' = 0.838\ ''K$$ (Ref. SCS-101C set 2 sh 124 R5)

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C Set 3		Sheet No. 247

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCCL	9/11/84						
Checker			L. PALMIERI	9-25-84						

Question 2.1.3 (con't)

CHECK BEAM: $L/a = \frac{6 \times 12}{18.0} = 4.0$

$\alpha_1 = 9/72 = 0.125$, $\alpha_2 = (9+24)/72 = 0.46$

REF. TO "TORSION ANALYSIS"
DESIGN DATA FROM BETHLEHEM STEEL

BY INTERPOLATION, CASE 6, FOR $z/L = 0.46$

conservative

$$\phi''\left(\frac{GJ}{M} \cdot a\right) = (0.0306 + 0.383) \times 2 = 0.8272$$

$$\phi'' = \frac{0.8272\ M}{GJa}$$

$$= \frac{0.8272 \times 0.838}{11.2 \times 10^3 \times 0.131 \times 18.0} = 0.026 \times 10^{-3}$$

$$\sigma_{n0} = E W_{n0} \phi''$$

$$= 29 \times 10^3 \times 5.11 \times 0.026 \times 10^{-3}$$

$$= 3.85^{ksi}$$

Since g_L is reduced from 2.67 to 1.75 (See SCS-101C Set 2, Sh 132, R5) & BEAM @ MIDSPAN IS CRITICAL (Sh. 126 R5)

$$\therefore \frac{0.795}{22}\Big|_{DL} + \left[\left(\frac{1.33}{22}\right)^2 + \left(\frac{1.04}{22}\right)^2 + \left(\frac{(19.56+3.85)}{22} \times \frac{1.75}{2.67}\right)^2\right]^{1/2}$$

$= 0.738 \ll 1.0$

Beam C8x11.5 is O.K and has 26.2% margin.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C Set 3 Sheet No. 248

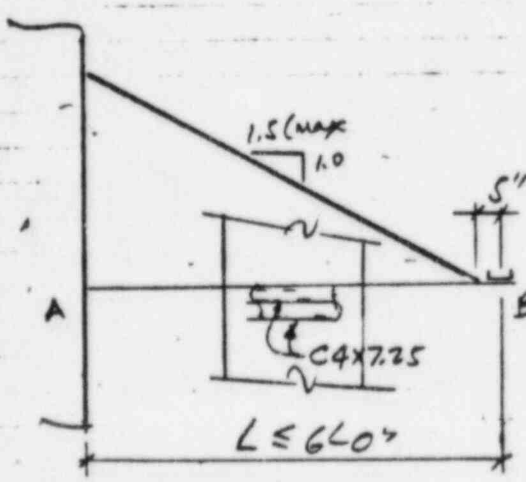
Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SCCL	9/11/84							
Checker			NV	9.17.84							

Question 2.1.3 (cont)

GROUP 2:

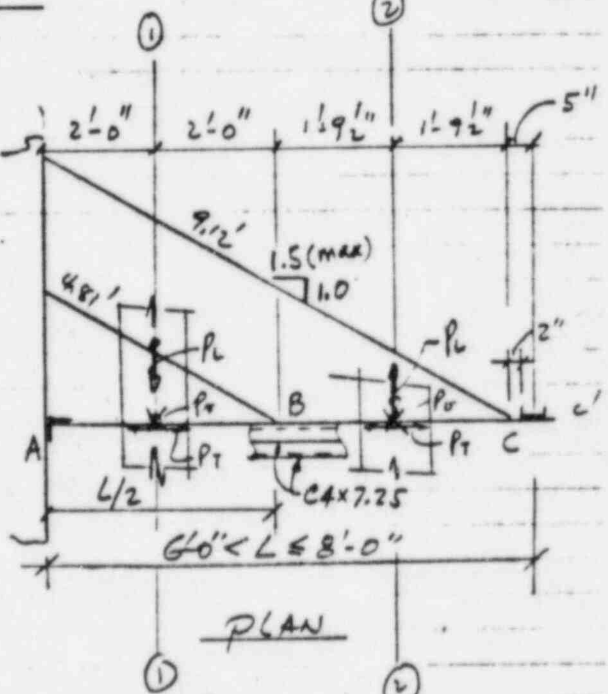
CASES D_i W/BR ($i = 1$ to 4):

Ref BK SCS-215C SET4 Sh 62 R0



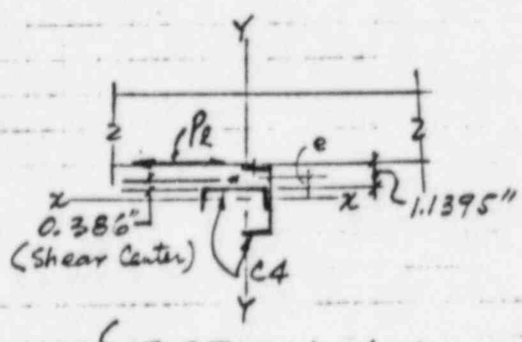
PLAN

CASE 2



PLAN

CASE 1



SECTION A-A

The inflection point:

$e = (1.1395 - 0.296 - \frac{1}{2} \times \frac{3}{16}) / 2$ (1/4 above 0.296; fillet weld)

$= 0.3905'' \sim 0.386''$

shear center of horiz channel (⊓).

There is no local torsional effect due to P_L since the inflection point lines up with the shear center of the horizontal C4 channel (⊓).

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

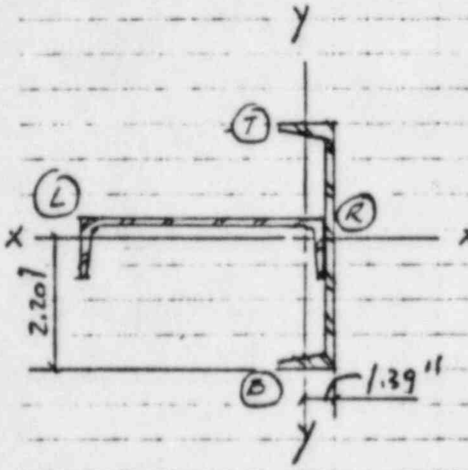
Subject CABLE TRAY SUPP'T. - RESPONSE TO CYGNA PHASE IV REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 249

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			NV	9.18.85							
Checker			Secs	9.26.84							

Question 2.1.3 (cont)

PROPERTY OF COMBINED SECTION:



$$\bar{x} = \frac{2.13(0.459 + 2.321)}{2 \times 2.13} = 1.39''$$

$$\bar{y} = \frac{2.13(2.0 + 2.4015)}{2 \times 2.13} = 2.20''$$

$$I_x = 4.54 + 0.433 + 2.13 \times \overline{0.201}^2 + 2.13 \times \overline{0.201}^2 = 5.195 \text{ IN}^4$$

$$I_y = 4.59 + 0.433 + 2.13 \times \overline{0.931}^2 + 2.13 \times \overline{0.931}^2 = 8.715 \text{ IN}^4$$

$$S_{x(T)} = \frac{5.195}{(4.0 - 2.201)} = 2.888 \text{ IN}^3 \qquad S_{x(B)} = \frac{5.195}{2.201} = 2.36 \text{ IN}^3$$

$$S_{y(L)} = \frac{8.715}{(4.321 - 1.39)} = 2.973 \text{ IN}^3 \qquad S_{y(R)} = \frac{8.715}{1.39} = 6.27 \text{ IN}^3$$

$$r_x = \sqrt{\frac{5.195}{2 \times 2.13}} = 1.104'' \; ; \; r_y = \sqrt{\frac{8.715}{2 \times 2.13}} = 1.43''$$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPP'T. – RESPONSE TO CYGNA PHASE IV REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 250

Revision	Original Issue	Date	Rev. #	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			NV	9.19.84						
Checker			Sech	9.25.84						

Question 2.1.3 (cont)

CASE 1:

REF. BK. SCS-215C SET 4 SH 62-64 R.0

$L = 8'-0''$ w/ 2-24" TRAYS $g_h = 1.10$

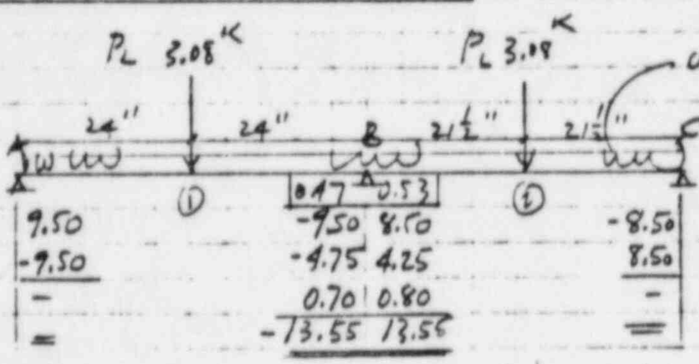
$P_V^{DL} = 0.035 \times 2 \times 8.5 \times 1.0 = 0.595^K$

$P_V^{EQ} = 1.67 \times P_V^{DL} = 0.994^K$

$P_T = 1.10\, P_V^{DL} = 0.655^K$ ($g_T = 1.05$ actually see SCS-101C set 3 sh 239 R9)

$P_L = 0.035 \times 2 \times 40 \times 1.10 = 3.08^K$

MOM. DUE TO LONGIT. LDS. P_L



$M_{F_{A,B}} = \frac{3.08 \times 24}{8} + \frac{0.0144 \times 1.1 \times 4 \times 48}{12} = 9.5^{"K}$

$M_{F_{B,C}} = \frac{3.08 \times 21.5}{8} + \frac{0.0144 \times 1.1 \times 3.58 \times 43}{12} = 8.5^{"K}$

$V_A = \frac{3.08 \times 24 + \frac{1}{2}(0.0144 \times 1.1 \times 4 \times 48) - 13.55}{48} = 1.29^K$

$V_c = \frac{3.08 \times 21.5 + \frac{1}{2}(0.0144 \times 1.1 \times 3.58 \times 43) - 13.55}{48} = 1.123^K$

$\Sigma V_B = 3.08 \times 2 + 0.0144 \times 1.1 \times 7.58 - 1.29 - 1.123 = 3.87^K$

$M_{①} = 1.29 \times 24 - \frac{1}{2}(0.0144 \times 1.1 \times 4 \times 48) = 29.4^{"K}$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPP'T. – RESPONSE TO CYGNA PHASE IV REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 251

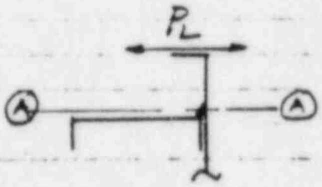
Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			NV	9.19.84							
Checker			[illegible]	9.25.84							

Question 2.1.3 (cont)

@ ①-① (SEE PLAN) CRITICAL

LOCAL BENDING STRESSES DUE TO P_L

$M^L_{Ⓐ-Ⓐ} = 3.08^K \times 0.3905'' = 1.203^{''K}$



EFFECTIVE WIDTH OF SECTION $24'' + 3'' + 3'' = 30''$

$S_{Ⓐ-Ⓐ} = \frac{1}{6} \times 30 \times \overline{0.321}^2 = 0.515 \text{ IN}^3.$

$f^L_{b\,Ⓐ-Ⓐ} = \frac{1.203}{0.515} = 2.34^{KSI.} < 27^{KSI.}$

CHECK BUILT-UP BEAM @ SECT. ①-①

$M^L_y = 29.4^{''K}$ (max.)

$P^L_{AXIAL} = (1.123 + 3.87) \times 1.5 = 7.49^K$

ADDIT'L Bm.

$P^T_{AXIAL} = 0.051 + [(0.051 \times 1.67)^2 + (0.0592 + 1.248 + 0.00725 \times 1.1 \times 8)^2]^{\frac{1}{2}} = 1.42^K$

REF. TO SET 3 SH. 240 R.9

$M^{D.L.}_x = 0.7823^{'K} \times 12 = 9.39^{''K}$

$M_x = 1.306^{'K} \times 12 = 15.7^{''K}$

Checking Method # 1 Line-by-line checking 2 Alternative Calculation Results compared 3 Identical Calculation Results compared 4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPT. - RESPONSE TO CYGNA PHASE IV REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 252

Revision	Orignal Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			NV	9.19.84						
Checker			SCCS	9.25.84						

Question 2.1.3 (cont);

$$f_{bx_{(T)}}^{D.L.} = \frac{9.39}{2.888} = 3.25 \text{ KSI.}$$

$$f_{bx_{(T)}}^{V} = \frac{15.7}{2.888} = 5.44 \text{ KSI.}$$

$$f_{by_{(L)}}^{L} = \frac{29.4}{2.973} = 9.89 \text{ KSI.}$$

$$f_a^{T} = \frac{1.42}{2\times 2.13} = 0.333 \text{ KSI.} \qquad \frac{f_a^L}{F_a} = \frac{1.758}{14.56} = 0.121 < 0.150$$

$$f_a^{L} = \frac{7.49}{2\times 2.13} = 1.758 \text{ KSI.}$$

$$\frac{Kl}{r_x} = \frac{1.0\times 96}{1.104} = 87 \rightarrow F_a = 14.56 \text{ KSI.}$$

INTERACTION FOR SEISMIC

$$\left[\left(\frac{3.25}{22}\right)_{DL.} + \sqrt{\left(\frac{5.44}{22}\right)^2 + \left(\frac{0.333}{14.56}\right)^2 + \left(\frac{1.758}{14.56} + \frac{9.89}{22}\right)^2}_{EQ}\right] \times 1.015 = 0.782 < 1.000$$

CONSERV. DUE TO ECCENTRICITY - SEE SCS-101C SET 1 SH 182 R.4

∴ BUILT UP BEAM 2-C4x7.25 (⊢⊣) IS ADEQUATE and has 21.8% margin.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 253

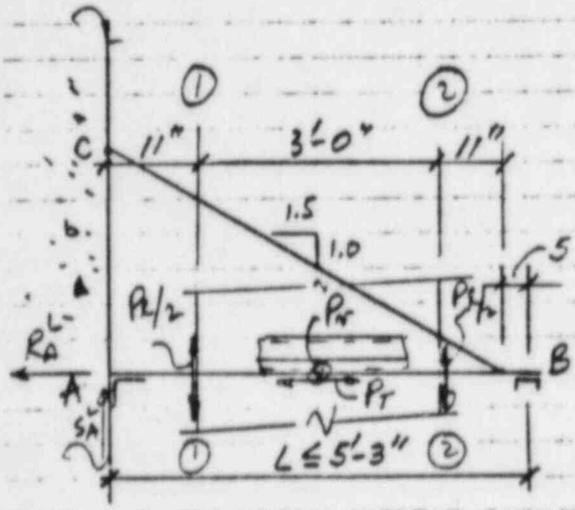
Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			Sec4	9.25.84						
Checker			NV	9.25.84						

Question 2.1.3 (cont)

Case D_i M/BR (i = 1 to 4) :

Case 2: Ref to SCS-215C SET 4 Sh 59 & 60 R0

$g_L = 1.848$



PLAN

$P_L = 0.035 \times 3 \times 40 \times 1.848 = 7.76^k$

$w_{AB} = 0.0145 \times 1.848 = 0.027$ k/'

$w_{BC} = 0.0072 \times 1.848 = 0.013$ k/'

$R_A^L = \left(\frac{7.76 \times 2.42}{4.83} + 0.027 \times 2.63 + 0.013 \times 4.5\right) \times 1.5$

$= 6.03^k$

$S_A^L = \frac{7.76}{2} + 0.027 \times 2.63 = 3.95^k$

LOCAL BENDING STRESSES DUE TO P_L:

$M_y^L = 7.76 \times 0.3905 = 3.03''^k$

$b_{eff} = 36 + 3 \times 2 = 42''$, $S_y = \frac{1}{6}(42)(0.321)^2 = 0.7213$ in³

$f_{by}^L = \frac{3.03}{0.7213} = 4.2^{ksi}$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS – RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 254

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Sgch	9.25.84						
Checker			NV	9.25.84						

Question 2.1.3 (cont)

CHECK BUILT-UP BEAM @ SECT ①-①

$M_y^L = 3.95 \times 11 = 43.45^{"K}$

$f_{by}^L = \frac{43.45}{2.973} = 14.61^{ksi}$

$f_a^L = \frac{6.03}{2 \times 2.13} = 1.42^{ksi}$,

Ref to Sh 250 Rev. 9;

$f_a^L/F_a = 1.42/14.56 = 0.098 < 0.15$

AISC 1.6-2

$$\left[\left(\frac{3.25}{22}\right)_{D.L.} + \sqrt{\left(\frac{5.44}{22}\right)_V^2 + \left(\frac{0.333}{14.56}\right)_T^2 + \left(0.098 + \frac{14.61}{22}\right)_L^2}\right] \times 1.015$$

$= 0.963 < 1.0$ O.K.

1.015: conservative, due to eccentricity SEE SCS-101C Set 1 Sh 182 R4

BUILT-UP BEAM 2-C4x7.25 IS ADEQUATE and has 3.7% margin

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

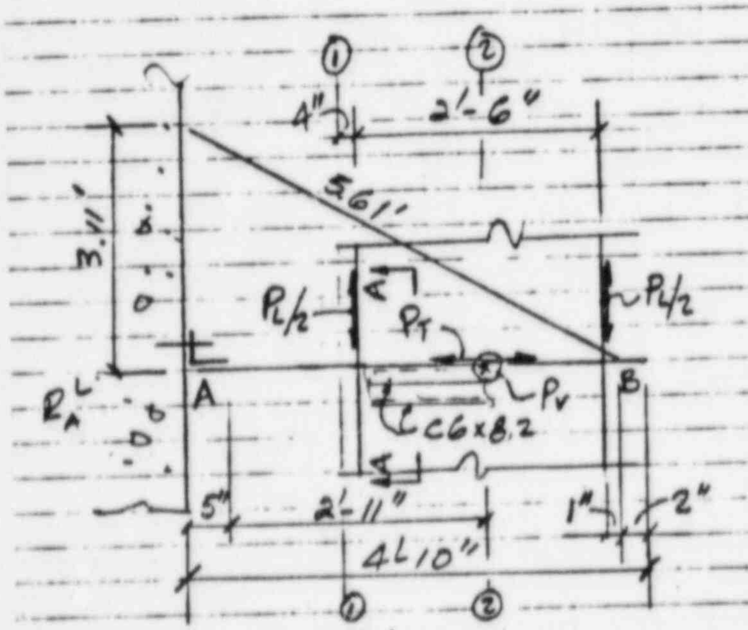
Subject CABLE TRAY Supts - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 255

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X	—	X
Preparer			Sech	2/9/84						
Checker			GPT	6/25/84						

Question 2.1.3 (cont)

Group 3: SP-7 w/BR

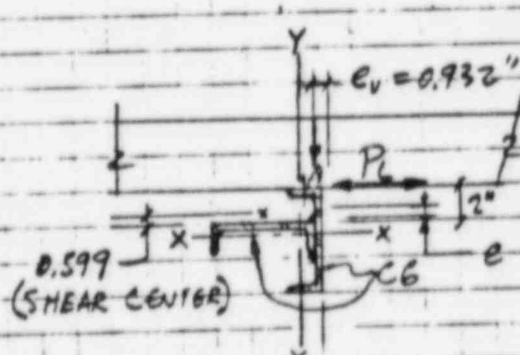


PLAN

2'-6" TRAY } Ref. SCS-146C
L = 4'10" } SET 1 Sh 24, R0

$g_V = g_T = 2.67$

$g_L = 1.12$ Ref SCS-215C Set 4 Sh 49 & 50 R0



SECTION A-A

ASSUMPTIONS:

1) TOP FLANGE OF VERT. CHANNEL (]) IS ALWAYS BEARING AGAINST BOTTOM OF THE TRAY DUE TO THE HEAVY LOAD P_L IN EITHER DIRECTION.

2) BECAUSE OF THE FLANGE, THE EFFECTIVE WIDTH WILL BE $b_{eff} = (2'-6") + 7" = 3'-1"$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS – Response to CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 256

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Chg./Supersed.			1							
Preparer			SCCS	7/9/84						
Checker			GRT	9/x/84						

Question. 2.1.3 (cont)

THE INFLECTION POINT, e,

$$e = \left(2'' - \frac{13''}{16} - \frac{1}{3} \times \frac{3''}{16}\right) / 2 = 0.5625''$$

$$e + \frac{1}{16}'' = 0.5625'' + \frac{1}{16}''$$

$$= 0.625'' \sim 0.599''$$ SHEAR CENTER OF THE HORIZ. C6 (⊓).

SINCE WEB OF THE CHANNEL IS NOT AS STIFF AS THE FLANGE AND THE COMBINED MEMBERS BETWEEN THE FILLET WELDS, AND BOTH THE STRONG X-X AXES OF THE TRAY AND THE HORIZ CHANNEL (⊓) ARE QUITE STIFF TO RESIST THE BENDINGS THROUGH BEARING AND DIRECT CONTACT RESPECTIVELY, THE INFLECTION POINT MAY THEN BE CONSIDERED AS A HINGE TO TRANSFER THE FORCE P_L TO THE HORIZ. CHANNEL (PORTAL METHOD). THEREFORE, THERE IS NO LOCAL TORSIONAL EFFECT DUE TO P_L BECAUSE THE INFLECTION POINT

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

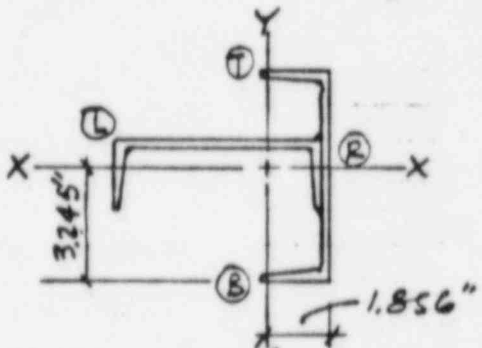
Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			sccl	2/10/84							
Checker			GRT	9/25/84							

Question 2.1.3 (cont)

THEORETICALLY LINES UP WITH THE SHEAR CENTER OF THE HORIZ. CHANNEL. THE LONG'L TRAY LOAD P_L, INSTEAD, WILL CREATE EQUAL LOCAL BENDINGS AT THE TOP FILLET OF WEB OF THE VERT. CHANNEL AND AT THE TOP FILLET WELD.

PROPERTIES OF THE BUILT-UP SECTION:

2 - C6×8.2



$$\bar{X} = \frac{2.4(0.511 + 3.2)}{2 \times 2.4} = 1.856''$$

$$\bar{Y} = \frac{2.4[3 + (4 - 0.511)]}{2 \times 2.4} = 3.245''$$

$$I_x = 13.1 + 0.693 + 2.4 \times 0.245^2 + 2.4 \times (6 - 3.245 - 2.511)^2 \doteq 14.08 \text{ IN}^4$$

$$I_Y = 13.1 + 0.693 + 2.4(1.856 - 0.511)^2 + 2.4(3.2 - 1.856)^2 = 22.47 \text{ IN}^4$$

$$S_{X_{T}} = \frac{14.08}{6 - 3.245} = 5.11 \text{ IN}^3; \quad S_{X_{B}} = \frac{14.09}{3.245} = 4.34 \text{ IN}^3$$

$$S_{Y_{R}} = \frac{22.47}{1.856} = 12.11 \text{ IN}^3; \quad S_{Y_{L}} = \frac{22.47}{6.2 - 1.856} = 5.17 \text{ IN}^3$$

$$r_x = \sqrt{\frac{14.08}{2 \times 2.4}} = 1.713 \text{ IN}; \quad r_y = \sqrt{\frac{22.47}{2 \times 2.4}} = 2.164 \text{ IN.}$$

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPTS - Response to CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 3		Sheet No. 258

Revision	Orignal Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SCC	3/11/84							
Checker			GRT	9/25/84							

Question 2.1.3 (cont)

CABLE TRAY LOADS:

$P_V^{D.L.} = 0.035 \times 2.5 \times 8.5 = 0.744^K$

$P_V = 1.67\ P_V^{D.L.} = 1.242^K$

$P_T = 2.67\ P_V^{D.L.} = 1.987^K$

$P_L = 0.035 \times 2.5 \times 40 \times 1.12 = 3.92^K$

LOCAL BENDING STRESSES DUE TO P_L (ACTING @ TOP FILLET OF WEB OF THE VERT. CHANNEL AND CENTROID OF THE TOP FILLET WELD).

$M_y^L = 3.92 \times 0.5625'' = 2.205''^K$

$S_y = \frac{1}{6}(37)(0.2)^2 = 0.247\ IN^3$

$f_{by}^L = 2.205/0.247 = 8.93^{ksi}$

CHECK BUILT-UP BEAM @ SECTION ①-①: (OR @ INNER SIDERAIL OF TRAY)

$P_{V\ BRACE}^{D.L.} = 0.0072 \times 5.61 = 0.04^K$

$M_{xx}^{D.L.} = 0.744 \times 1.58 + \frac{1}{2}(0.0164)(3.01)^2 + 0.02 \times 2.92 = 1.31'^K$

$M_{xx}^V = 1.67\ M_x^{D.L.} = 2.19'^K$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO

Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 259

5

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCEB	9/18/84						
Checker			GRT	9/25/84						

Question 2.1.3 (cont)

$$\Sigma P_T = 1.987 + (0.0164 \times 4.83 + 0.02) \times 2.67 = 2.25^k$$

$$R_A^L = \left[\frac{3.92}{2}(4.58 + 2.08) + (0.0164 \times 2.42 + 0.02 \times 4.67) \times 1.12 \right] / 3.11$$

$$= 4.25^k$$

$$M_{YY}^L = (3.92/2)(20)(31)/51. = 23.83^{''k}$$

$$f_{bx①}^{D.L.} = \frac{1.31 \times 12}{5.11} = 3.08^{ksi}$$

$$f_{bx①}^{V} = 1.67 \times 3.08 = 5.14^{ksi}$$

$$f_a^T = \frac{2.25}{2.4 \times 2} = 0.47^{ksi}$$

$$f_a^L = 4.25/(2.4 \times 2) = 0.89^{ksi}$$

$$f_{by②}^L = \frac{23.83}{12.11} = 1.97^{ksi}$$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Seek	2/8/85						
Checker			GRT	9/25/84						

7

Question 2.1.3 (cont)

STRESSES @ TOP F.-LET OF WEB OF VERT. CHANNEL IS CRITICAL.

$$f^{D.L.}_{bx_{F①②}} = f^{D.L.}_{bx①} \times \frac{(6-3.201-13/16)}{(6-3.201)}$$

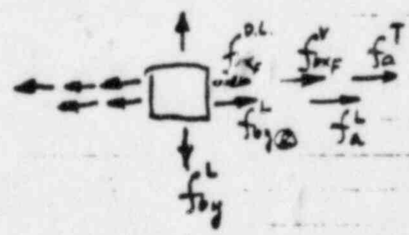
$$= 3.08 \times 0.7097 = 2.19^{ksi}$$

$$f^{V}_{bx_{F①②}} = f^{V}_{bx①} \times 0.7097$$

$$= 5.14 \times 0.7097 = 3.65^{ksi}$$

$f^{T}_{a} = 0.47^{ksi}$, $f^{L}_{a} = 0.89^{ksi}$

$f^{L}_{by②} = 1.97^{ksi}$, $f^{L}_{by} = 8.93^{ksi}$



$$\left.\frac{Kl}{r}\right)_x = \frac{2 \times 4.42 \times 12}{1.713} = 62. \rightarrow F_a = 17.24^{ksi}$$

$$F_{bx} = \frac{1000 \times 12}{9.1 \times 4.42 \times 12} = 24.9^{ksi} \quad \text{USE } 22.^{ksi}$$

$$f^{L}_{a}/F_a = 0.89/17.24 = 0.052 < 0.15$$

AISC 1.6-2 FOR SEISMIC

$$\left.\frac{2.19}{22}\right)_{D.L.} + \sqrt{\left(\frac{3.65}{22}\right)^2_V + \left(\frac{0.47}{17.24}\right)^2_T + \left(\frac{0.89}{17.24} + \frac{1.97}{22}\right)^2_L + \left(\frac{8.93}{27}\right)^2_L}$$

$$= 0.50 < 1.0$$ Beam is O.K.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 261

8

Revision	Original Issue	Date	Rev. 5	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SCD	9/21/84							
Checker			GET	9/25/84							

Question 2.1.3 (cont)

STRESSES @ TOP FLANGE OF VERT. CHANNEL.

$f_{bx}^{D.L.} = 3.08$ ksi

$f_{bx}^{V} = 5.14$ ksi

$f_a^T = 0.47$ ksi, $f_a^L = 0.89$ ksi

$f_{by②}^{L} = 1.97$ ksi

$$f_{by}^{L} = 8.93 \times \frac{(0.5625 + \frac{13}{16} - 0.343)}{0.5625} \times \left(\frac{0.2}{0.343}\right)^2 = 5.57 \text{ ksi}$$

AISC 1.6-2 FOR SEISMIC.

$$\left.\frac{3.08}{22}\right)_{D.L.} + \sqrt{\left(\frac{5.14}{22}\right)_V^2 + \left(\frac{0.47}{17.24}\right)_T^2 + \left(\frac{0.89}{17.24} + \frac{1.97}{22}\right)_L^2 + \left(\frac{5.57}{27}\right)_L^2}$$

$= 0.483 < 1.0$ ∴ O.K.

BUILT-UP BEAM (⊓) IS O.K.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 262

Revision	Original Issue	Date	Rev. 5	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCCL	9/25/84						
Checker			GET	9/25/84						

Question 2.1.3 (cont)

CHECK Built-up BEAM @ SECT ②-②:

Stresses @ Top fillet of web of Vertical channel is critical, by proportion

$$f^{D.L.}_{bx\,T\,②-②} = \frac{1.25}{2.83} \times f^{D.L.}_{bx\,T\,①-①} = \frac{1.25}{2.83} \times 3.08 = 1.36^{ksi}$$

$$f'_{bx\,T\,②-②} = 1.67 \times 1.360 = 2.27^{ksi}\ ;\ f_a^T = 0.47^{ksi}$$

$$f^{D.L.}_{bx\,F\,②-②} = 1.36 \times 0.7097 = 0.97^{ksi}\ ;\ f_a^L = 0.89^{ksi}$$

$$f^{D.L.}_{bx\,F\,②-②} = 2.27 \times 0.7097 = 1.611^{ksi}\ ;\ f_{by}^L = 8.93^{ksi}$$

$$M^L_{y\text{-}y\,②-②} = \left(\frac{3.92}{2} \times \frac{2.17}{4.67}\right) \times 16 = 14.57^{''K}$$

$$f^L_{by\,②} = \frac{14.57}{12.11} = 1.20^{ksi}$$

AISC 1.6-2 for Seismic

$$\left.\frac{0.97}{22}\right)_{D.L.} + \sqrt{\left(\frac{1.611}{22}\right)^2 + \left(\frac{0.47}{17.24}\right)_T^2 + \left(\frac{0.89}{17.24} + \frac{1.2}{22}\right)_L^2 + \left(\frac{8.93}{27}\right)_L^2}$$

$= 0.40 < 1.0$ O.K.

∴ Built-up beam ⊐ is adequate

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C set 1		Sheet No. 175

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SCCS	9.22.84						
Checker			WC	9-26-84						

Question 2.2: (CYGNA LTR 84056.031 ATTACHMENT A)

Eccentric connections between hangers & beams

Purpose: To evaluate the effects of eccentric connections between hangers & beams of cable tray supports.

References:

1. Letter 84056.031 from CYGNA to Mr. J. B. George of TUGCO dated Aug. 31, 1984, Attachment A, item 2.2
2. DWG's 2323-S-0901/4 & S-0903/5
3. BK SCS-101C set 1
4. BK SCS-101C set 3

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPT'S - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 176

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SCC	9.22.84						
Checker			VMC	9-26-84						

Question 2.2 (CONT)

Justification:

Stresses due to the eccentric connection of channel sections for the hanger and beam members are generally small and therefore neglected in engineering practice in the design of structural frames. The cable tray raceway system containing the cable tray and its supports can be considered as a space frame. The additional stresses due to the eccentric connections between hanger & beam are found to be small and can be neglected. See Sh. 182 R4

The following calculations demonstrate the acceptability of the original assumption of neglecting the stresses due to the eccentric connections and the adequacy of the cable tray supports.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO

Subject: CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

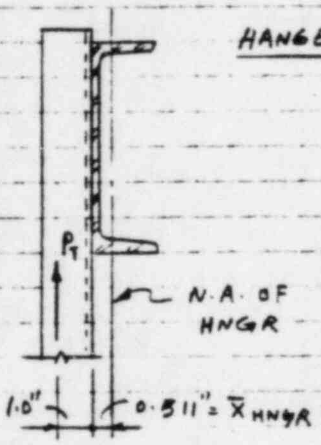
Calculation Number: SCS-101C SET 1 Sheet No. 177

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			MC	9-19-84							
Checker			SCC	9.26.84							

QUESTION 2.2 (CONT'D)

i) EFFECT OF ECCENTRIC CONN. FOR THE TRANSVERSE LOADS:

REFER TO THE STIFFNESS ANALYSIS SHOWN ON SH. 156 TO 159 R 4



PLAN

HANGER $\Delta M^T = P_T \times \frac{\ell}{12}$

REF. TO SH. 160 R.4

$\Delta P_T = 0.2322\ \Delta M^T = 0.2322\ P_T \times \frac{\ell}{12}$

$= 0.0193\ \ell\ P_T$

$\frac{\Delta P_T}{P_T} = 0.0193\ \ell$ (ALSO REFER TO SH. 161 R.4)

FROM LOAD P_T TO C.G. OF HANGER, $\ell = 1.0 + 0.511$

$= 1.511$ IN

$\frac{\Delta P_T}{P_T} = 0.0193 \times 1.511 = 0.029$

$= 2.9\ \%$

TRAY $\frac{\Delta M_y^T}{M_y^T} = 0.081\ \ell$ (REFER TO SH. 161 R 4)

$= 0.081 \times 1.511 = 0.122$

$= 12.2\ \%$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 1		Sheet No. 178

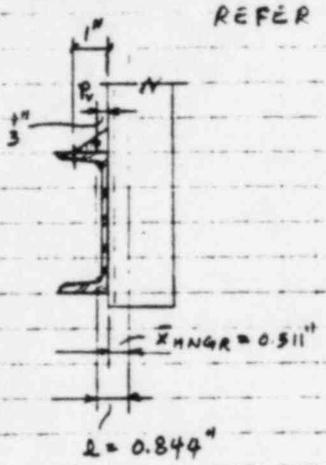
Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			MC	9-19-84						
Checker			SCCS	9-26-84						

QUES: 2.2 (CONT'D)

ii) EFFECT OF ECCENTRIC CONN. FOR THE VERTICAL LOADS:

REFER TO THE STIFFNESS ANALYSIS ON SH. 167 & 168 R.4

DUE TO VERT. LOAD



HANGER $\frac{\Delta P_v}{P_v} = 0.0193\,\ell$

$= 0.0193 \times 0.844 = 0.0163$

$= 1.63\,\%$

TRAY $\frac{\Delta M_x^V}{M_x^V} = 0.081\,\ell$

$= 0.081 \times 0.844 = 0.068$

$= 6.8\,\%$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO

Subject: CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number: SCS-101C SET 1 — Sheet No. 179

Revision	Orig. Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			MC	9-19-84							
Checker			SCCS	9-26-84							

QUESTION 2.2 (CONT'D)

CHECK TRAY

FOR REFINED 'g' VALUES, SEE SCS-101C SET 5 SHT'S 16 TO 20 R.2

Aux. Bldg. Elev. 899.5' SSE w/ 5% damping (Conservative)

$g_H = 3.38$ $g_V = 2.61$ (governing case)

NOTE: No cable tray exists above ELEV. 885.5' in the Reactor Bldg.

FROM VENDOR DATA, THE TRAYS WITH CRITICAL INTERACTION ARE:

GF-36SL, GG-12SL-12-06-CP & GG-24SL-12-06

DUE TO ECCENTRICITY FROM C.G. OF HANGER

VERT. LD. WILL INCREASE 6.8 % (CRITICAL)

TRANSV. LD. WILL INCREASE 12.2 % (CRITICAL)

TRAY GF-36SL: $1.6\left[\frac{105\times1.068}{925}+\sqrt{\left(\frac{2.61\times105\times1.068}{925}\right)^2+\left(\frac{3.38\times105\times1.122}{1010}\right)^2+\left(\frac{3.38\times105}{2\times5588^{*}}\right)^2}\right]$

$= 1.6\left[0.1212+\sqrt{0.10012+0.15544+0.00103}\right]$

$= 1.004 \cong 1.0$

$* \; P_c = \frac{2\pi^2 EI}{\ell^2}$

SEE SCS-111C SET 7 SH. 4 & 5 R.0

TRAY GG-12SL-12-06-CP:

$1.6\left[\frac{35\times1.068}{265}+\sqrt{\left(\frac{2.61\times35\times1.068}{265}\right)^2+\left(\frac{3.38\times35\times1.122}{424}\right)^2+\left(\frac{3.38\times35}{2\times1295^{*}}\right)^2}\right]$

$= 1.6\left[0.1411+\sqrt{0.13554+0.0980+0.00209}\right] = 1.002 \cong 1.0$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1 Sheet No. 180

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			Scch	9.22.84							
Checker			W.C	9-26-84							

Question 2.2 (cont)

TRAY GG-24SL-12-06 :

$$1.6\left[\frac{70\times1.068}{675}+\sqrt{\left(\frac{2.61\times70\times1.068}{675}\right)^2+\left(\frac{3.38\times70\times1.122}{650}\right)^2+\left(\frac{3.38\times70}{2\times4,075}\right)^2}\right]$$

$$=1.6\left[0.1108+\sqrt{0.0836+0.1668+0.00084}\right]$$

$$=0.98<1.0 \quad \text{O.K.}$$

∴ All types of cable trays are adequate

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			Sech	9-22-84							
Checker			WC	9-24-84							

Question 2.2 (cont.)

Summary & conclusion:

EFFECT OF ECCENTRIC CONNECTIONS BETWEEN HANGERS AND BEAMS

P_V: Vertical loads ; P_T: Transverse load

SUPPORT CASE i=1 to 4	HANGER		TRAY		REMARKS
	$\Delta P_V / P_V$	$\Delta P_T / P_T$	$\Delta P_V / P_V$	$\Delta P_T / P_T$	
A_i, B_i, C_i	* 1.63%	* 2.9%	6.8%	12.2%	TRAYS ARE ADEQUATE
D_i & D_i W/BR	* 1.63%	-	6.8%	-	SAME AS ABOVE
SP-7, SP-7 W/BR	-	-	-	-	
L-A_i, L-B_i, L-C_i	-	-	-	-	

*: SEE Sh 182 R4 for conclusion.

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 1	Sheet No. 182	

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCC	9.24.84						
Checker			WC	9-26-84						

Questions 2.1.1, 2.1.2 & 2.2 (cont)

CONCLUSION: (for overall effect due to eccentric loads & connections)

1. All types of cable trays are adequate
2. Tray support cases SP-7 & SP-7 W/BR ARE adequate
3. No effect on longitudinal tray supts cases $L\text{-}A_i$, $L\text{-}B_i$ & $L\text{-}C_i$
4. Effects on other generic supports are minor as illustrated in the table below.

SUPPORT CASES $i = 1$ to 4	HANGER		BEAM				REMARKS (Ref to sh. 162 & 163 R4)
			@ END		@ BOLT HOLE		
	$\Delta P_V/P_V$	$\Delta P_T/P_T$	$\Delta P_V/P_V$	$\Delta P_T/P_T$	$\Delta P_V/P_V$	$\Delta P_T/P_T$	
A_i, B_i, C_i	1.63%	2.9%	1.39%	① 1.09%	1.39%	② 3.49% ☆	① 1.0005 x 1.0104 - 1 = 1.09% ② 1.0242 x 1.0104 - 1 = 3.49%
D_i ; D_i W/BR	1.63%	① 1.06%	1.39%	② 1.54%	*	*	① 1.0002 x 1.0104 - 1 = 1.06% ② 1.0049 x 1.0104 - 1 = 1.54%

*: Stresses @ bolt hole location of beam are not critical.

☆: Not govern, since stress @ end of beam is higher ref to SCS-111C set 8 sh 39 R2.

MOMENT @ END $= M^T$ in-k

$$f^T_{bx@END} = M^T/2.29 = 0.4367 M^T \text{ ksi}$$

$$f^T_{bx@BOLT} = \left(M^T - M^T \times \frac{0.75}{3.0}\right) \times \frac{1}{1.948} = 0.385 M^T \text{ ksi} < 0.4367 M^T \text{ ksi}$$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 233

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SCCL	9.24.84						
Checker			WC	9.26.84						

Purpose: To verify adequacy of the tray support case D_1 including effects due to eccentric loads & connections

References:

1. Letter 84056.031 from CYGNA to Mr. J. B. George dated 8-31-84, Attachment A, item 2
2. DWG 2323-S-0903/5
3. BK. SCS-101C SET 1

Justification:

The horizontal earthquake intensity g_h has been recalculated to eliminate the conservatism used in the original design. The result shows that the original design still has 6.6% margin

The following calculations demonstrate the adequacy of the tray support case D_1.

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 3		Sheet No. 234

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SCCh	9/8/84						
Checker			VIC	9-26-84						

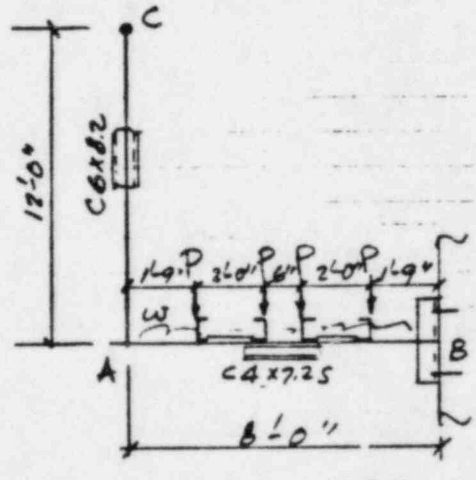
CASE D1:

$$\frac{I_x}{l}\bigg|_{AC} = \frac{13.1}{12.} = 1.092 = K_{AC}$$

$$\frac{I_x}{l}\bigg|_{AB} = \frac{4.59}{8} = 0.5738 = K_{AB}$$

$$Df_{AC} = \frac{1.092 \times 0.75}{0.5738 + 1.092 \times 0.75} = 0.59$$

$$Df_{AB} = 1 - 0.59 = 0.41$$



ELEVATION

DEAD LOAD:

$$P^{D.L.} = 0.035 \times 2 \times 8.5/2 = 0.2975^{k} \quad , \quad w^{DL} = 0.00725^{k}/_{1}$$

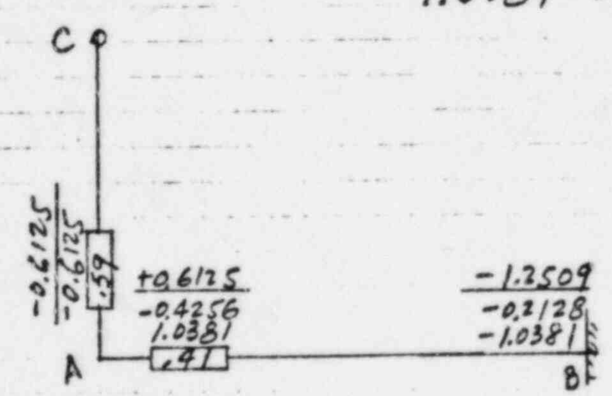
$$M^{F,DL.}_{AB} = \frac{1}{12}(0.00725) \times 8^2 = 0.0387^{k'}$$

$$0.2975 \times 1.75\left(1 - \frac{1.75}{8}\right) = 0.4067$$

$$0.2975 \times 3.75\left(1 - \frac{3.75}{8}\right) = 0.5927$$

$$1.0381^{k'}$$

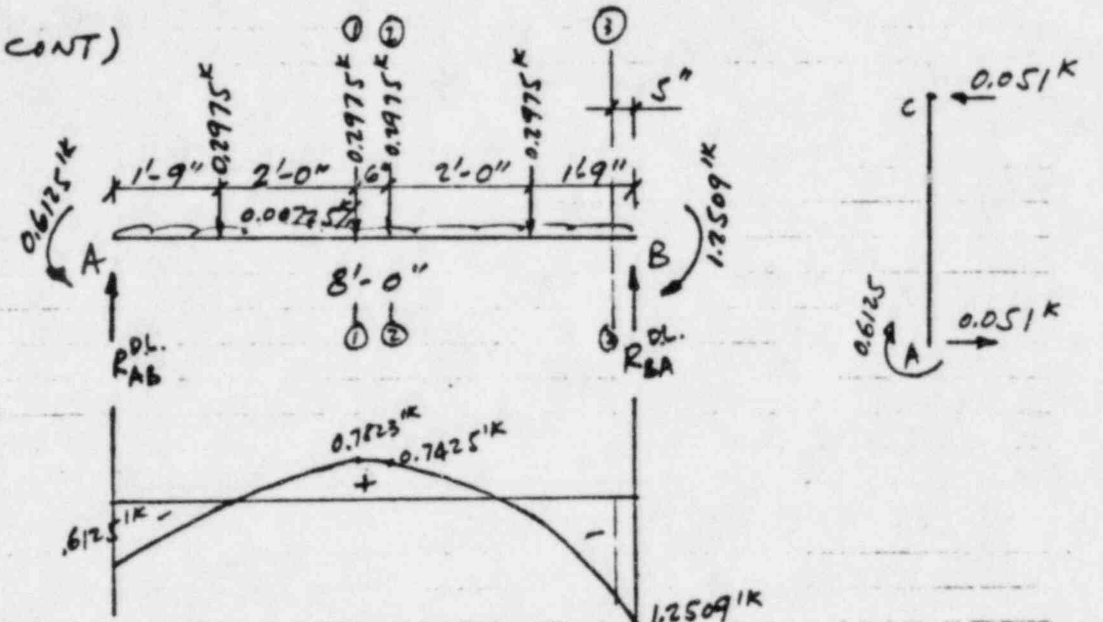
(+)



Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW		
Calculation Number SCS-101C SET 3		Sheet No. 235

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Seeh	9/8/84						
Checker			MC	9-26-84						

CASE D1 (CONT)



$$R_{AB}^{D.L.} = \frac{\frac{1}{2}(0.00725)8^2 + 0.2975(1.75+3.75+4.25+6.25) + 0.6125 - 1.2509}{8.0} = 0.5442^K$$

$$R_{BA}^{D.L.} = 0.2975 \times 4 + 0.00725 \times 8 - 0.5442 = 0.7038^K$$

$$M_{①-①}^{D.L.} = [0.5442 \times 3.75 - 0.6125 - 0.2975 \times 2 - \tfrac{1}{2}(0.00725) \times 3.75^2]$$

$$= 0.7823'^K$$

$$M_{②-②}^{D.L.} = [0.5442 \times 4.25 - 0.6125 \cdot 0.2975(0.5+2.5) - \tfrac{1}{2}(0.00725) \times 4.25^2] = .7425'^K$$

$$M_{③-③}^{D.L.} = 0.7038 \times \frac{5}{12} - 1.2509 = -0.9577'^K$$

VERTICAL SEISMIC:

$$M_{AB}^{V} = -M_{AC}^{V} = 1.67 \times 0.6125 = 1.0229'^K$$

$$M_{BA}^{V} = 1.67 \times 1.2509 = 2.089'^K; \quad M_{③-③}^{V} = 1.67 \times 0.9577 = 1.5994'^K$$

$$M_{①-①}^{V} = 1.67 \times 0.7823 = 1.3064'^K; \quad M_{②-②}^{V} = 1.67 \times 0.7425 = 1.2398'^K$$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

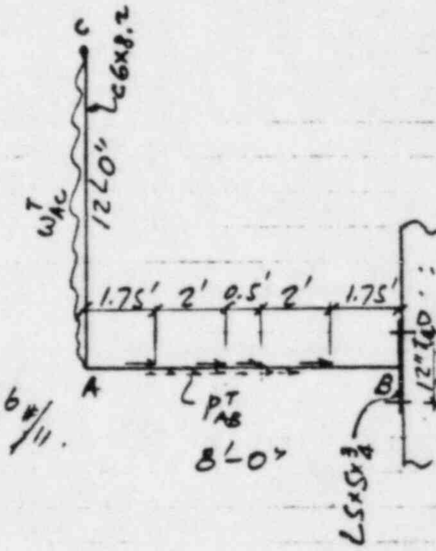
Calculation Number SCS-101C SET 3 Sheet No. 236

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SCCS	9/10/84						
Checker			M.C	9-26-90						

CASE D_1 (CONT)

TRANSVERSE SEISMIC:

MEMBER AC:



$$\Delta_{max} = \frac{w l^4}{185 EI}$$

$$k_{AC} = \frac{(wl)}{\Delta} = \frac{185\,EI}{l^3}$$

$$= \frac{185 \times 29 \times 10^6 \times 13.1}{(144)^3} = 0.02354 \times 10^6 \text{ \#/in.}$$

$$wl = 8.2 \times 12 = 98.4\ \#$$

$$f_{AC} = \frac{1}{2\pi}\sqrt{\frac{K}{M}} = \frac{1}{2\pi}\sqrt{\frac{0.02354 \times 10^6 \times 386.4}{98.4}} = 48.4 \text{ hz}$$

MEMBER AB IS VERY STIFF TO RESIST THE AXIAL FORCE.

BEAM CONN. @ B:

$$k_B = \frac{P}{\Delta} = \frac{48\,EI}{l^3} = \frac{48 \times 29 \times 10^6 \times 15.7}{30^3} = 0.8094 \times 10^6 \text{ \#/in}$$

$$P = 0.2975 \times 4 + 0.0082 \times 6 + 0.00725 \times 8 + 0.0236 \times \frac{30}{2 \times 12} = 1.327^K$$

$$f_B = \frac{1}{2\pi}\sqrt{\frac{0.8094 \times 10^6 \times 386.4}{1327.}} = 77.3 \text{ hz}$$

Checking Method # 1 Line-by-line checking 2 Alternative Calculation Results compared 3 Identical Calculation Results compared 4 Compare inputs and results of computer with corresponding inputs and results of similar codes

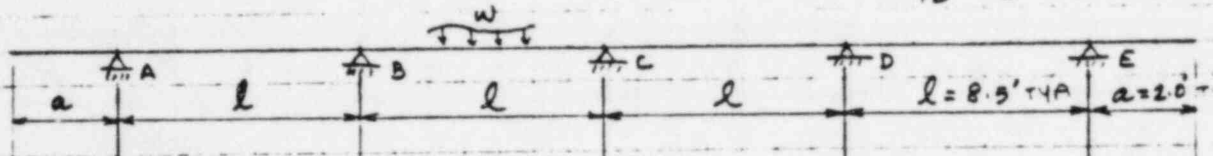
Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-25-84						
Checker			NV	9.26.84						

CASE D1 (CONT'D)

CABLE TRAY

OVERHANG MOM. $= \frac{1}{2} w a^2 = \frac{1}{2} w \times \left(\frac{2.0}{8.5} l\right)^2 = 0.0277 w l^2$

FIXED END MOM. $= \frac{1}{12} w l^2 = 0.0833 w l^2$



	A		B		C		D		E
DIST. FACTOR	1.0	3/7	4/7	0.5	0.5	4/7	3/7	1.0	
-0.0277	+0.0833 -0.0556	-0.0833	+0.0833	-0.0833	+0.0833	-0.0833	+0.0833	-0.0833 +0.0556	+0.0277
		-0.0278 +0.0119	+0.0159	+0.0079	-0.0079	-0.0159	+0.0278 -0.0119		
-0.0277	+0.0277	-0.0992	+0.0992	-0.0754	+0.0754	-0.0992	+0.0992	-0.0277	+0.0277

DEFLECTION. FROM AISC 2-125, 8TH ED.

EXTERIOR SPAN (SPAN DE)

$M_1 = 0.0992\, w l^2$

$M_2 = 0.0277\, w l^2$

$$\Delta_x = \frac{w x}{24EI}\left[x^3 - (2l + 4\times0.0992 l - 4\times0.0277 l)x^2 + 12\times0.0992 l^2 x + l^3 - 8\times0.0992 l^3 - 4\times0.0277 l^3)\right]$$

$$= \frac{w x}{24EI}\left[x^3 - 2.286 l x^2 + 1.1904 l^2 x + 0.0956 l^3\right]$$

$$\frac{d\Delta_x}{dx} = \frac{w}{24EI}\left[4x^3 - 6.858 l x^2 + 2.3808 l^2 x + 0.0956 l^3\right] = 0$$

BY TRIAL & ERROR, $x = 0.5474 l$

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO	
Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW			
Calculation Number SCS - 101C	SET 3	Sheet No. 238	

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MC	9-25-84						
Checker			NV	9.26.84						

CASE Di (CONT'D)

EXT. SPAN (CONT'D)

$$MAX\ \Delta = \frac{wl^4}{24EI} \times 0.5474\left[0.5474^3 - 2.286\times 0.5474^2 + 1.1904\times 0.5474 + 0.0956\right]$$

$$= 0.00516\ \frac{wl^4}{EI}$$

INTERIOR SPAN (SPAN BC)

$$M_1 = 0.0992\ wl^2$$

$$M_2 = 0.0754\ wl^2$$

$$\Delta_x = \frac{wx}{24EI}\left[x^3 - (2l + 4\times 0.0992 l - 4\times 0.0754 l)x^2 + 12\times 0.0992 l^2 x + l^3 - 8\times 0.0992 l^3 - 4\times 0.0754 l^3\right]$$

$$= \frac{wx}{24EI}\left[x^3 - 2.0952\, l x^2 + 1.1904\, l^2 x - 0.0952\, l^3\right]$$

$$\frac{d\Delta x}{dx} = 0 \Rightarrow 4x^3 - 6.2856\, l x^2 + 2.3808\, l^2 x - 0.0952\, l^3 = 0$$

BY TRIAL & ERROR $x = 0.5262\, l$

$$MAX.\ \Delta = \frac{wl^4}{24EI} \times 0.5262\left[0.5262^3 - 2.0952\times 0.5262^2 + 1.1904\times 0.5262 - 0.0952\right]$$

$$= 0.00212\ \frac{wl^4}{EI}$$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUP'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 239

Revision	Original Issue	Date	Rev. 4	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			sech	9-25-84							
Checker			WC	9-26-84							

Case D_1 (cont)

exterior span:

$$\Delta_{ext} = \frac{0.00516(wl)(8.5\times12)^3}{29\times10^6\times4.13} = 45.72\times10^{-6}(wl) \ ''$$

$$k_{ext} = \frac{1}{\Delta_{ext}} = 0.02187\times10^6 \ \#/'' \quad , (wl = 1^{\#})$$

$$wl = 35\times2\times8.5 = 595^{\#}$$

$$f_t = \frac{1}{2\pi}\sqrt{\frac{0.02187\times10^6\times386.4}{595}} = 18.97 \ hz$$

$$\Sigma f = \frac{1}{\sqrt{\frac{1}{f_{Ae}^2}+\frac{1}{f_B^2}+\frac{1}{f_t^2}}} = \frac{1}{\sqrt{\frac{1}{48.4^2}+\frac{1}{77.3^2}+\frac{1}{18.97^2}}} = 17.22 \ hz$$

$g_{h_{ext}} = 1.249$ Ref. DMI-11C set 3 Sh 19 R0

Interior span:

$$k_{int} = \frac{0.00516}{0.00212}\times0.02187\times10^6 = 0.05323\times10^6 \ \#/''$$

$$f_t = \frac{1}{2\pi}\sqrt{\frac{0.05323\times10^6\times386.4}{595}} = 29.6 \ hz$$

$$\Sigma f = \frac{1}{\sqrt{\frac{1}{48.4^2}+\frac{1}{77.3^2}+\frac{1}{29.6^2}}} = 24.0 \ hz$$

$\Rightarrow g_{h_{int}} = 0.82$

$$g_{avg} = \frac{1}{2}(g_{ext}+g_{int}) = \frac{1}{2}(1.249+0.82) = 1.035$$

USE $\boxed{g_h = 1.05}$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW

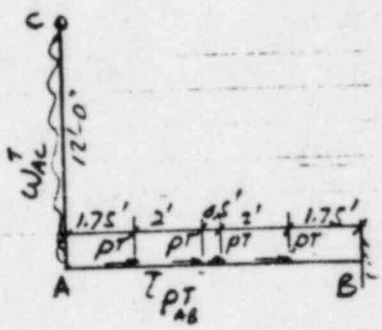
Calculation Number SCS-101C SET 3 Sheet No. 240

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			Sccb	9/8/84							
Checker			MC	9-26-84							

CASE D1 (CONT)

TRANSVERSE SEISMIC:

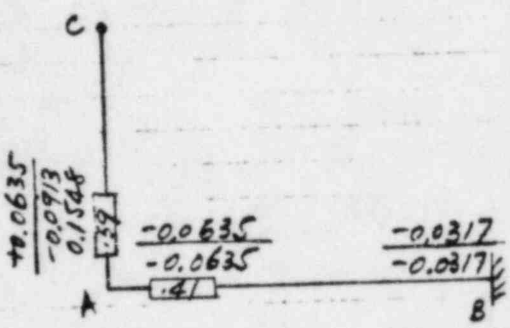
$$\omega_{AC}^{T} = 1.05 \times 0.0082 = 0.0086\ ^{K}/_{1}$$

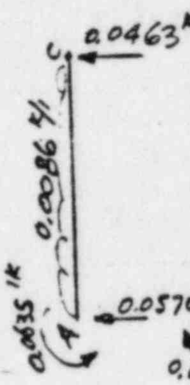


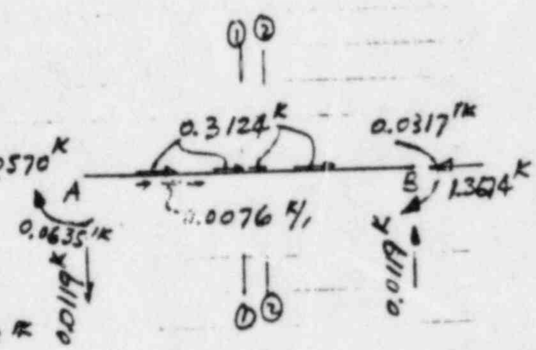
$$P_{AB}^{T} = 1.05 \times 0.00725 = 0.0076\ ^{K}/_{1}$$

$$P^{T} = 1.05 \times P^{D.L.} = 1.05 \times 0.2975 = 0.3124^{K}$$

$$M_{AC}^{F,T} = \frac{1}{8}(0.0086)(12)^2 = 0.1548^{1K}$$







$$M_{0-1}^{T} = -0.0635 + 0.0119 \times 3.75 = -0.0189^{1K}$$

$$M_{1-2}^{T} = -0.0635 + 0.0119 \times 4.25 = -0.0129^{1K}$$

$$M_{2-3}^{T} = 0.0119 \times \frac{5}{12} - 0.0317 = -0.0267^{1K}$$

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
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4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REIEW

Calculation Number SCS-101C SET 3 Sheet No. 241

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Seeh	9/8/84						
Checker			MC	9-26-84						

CASE D1 (CONT)

CHECK HGR C6×8.2

$$P_{AC}^{DL} = R_{AB}^{DL} + 0.0082 \times 12 = 0.5442 + 0.0984 = 0.6426^{K}$$

DOWNWARD SEISMIC

$$\Sigma P_{AC} = \underset{DL}{0.6426} + \left[(\underset{V}{0.6426 \times 1.67})^2 + \underset{T}{0.0119^2}\right]^{1/2} = 1.716^{K} \text{ TENSION}$$

$$\Sigma M_{AC} = 0.6125 + (1.0229^2 + 0.0635^2)^{1/2} = 1.6372^{'K}$$

$$F_{bx} = \frac{12 \times 10^3}{12 \times 12 \times 9.1} = 9.16^{ksi};$$

$$f_a = 1.716/2.4 = 0.715^{ksi} \text{ (TENSION)}; \; f_{bx} = \frac{1.6372 \times 12}{4.38} = 4.49^{ksi}$$

AISC 1.6-1b

*: Ref to SCS-101C set 1 Sh 182 R4

$$\left(\frac{0.715}{22} + \frac{4.49}{9.16}\right) \times 1.0163^{*} = 0.532 < 1.0$$

O.K.

UPWARD SEISMIC:

$$\Sigma P_{AC} = +0.6426 - \left[(0.6426 \times 1.67)^2 + 0.0119^2\right]^{1/2} = -0.431^{K} \text{ (COMP.)}$$

$$\Sigma M_{AC} = +0.6125 - (1.0229^2 + 0.0635^2)^{1/2} = -0.412^{'K}$$

$$f_a = 0.431/2.4 = 0.18^{ksi}; \; f_{bx} = \frac{0.412 \times 12}{4.38} = 1.13^{ksi}$$

$$\left.\frac{Kl}{r}\right)_y = \frac{0.7 \times 12 \times 12}{0.537} = 187.7 \Rightarrow F_a = 4.24^{ksi}$$

$$f_a/F_a = 0.18/4.24 = 0.0425 < 0.15$$

AISC 1.6-2 $\left(0.0425 + \frac{1.13}{9.16}\right) \times 1.0163^{*} = 0.169 < 1.0$ O.K.

HGR C6×8.2 IS ADEQUATE

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY Sup'TS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 242

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Sech	9/10/84						
Checker			MC	9-26-84						

CASE D1 (CONT)

CHECK BEAM C4x7.25:

@ point B : CRITICAL

$\Sigma P_{AB\,max} = 0.051 + [(0.051 \times 1.67)^2 + 1.3674^2]^{1/2} = 1.421^K$

$\Sigma M_{BA} = 1.2509 + (2.089^2 + 0.0317^2)^{1/2} = 3.34^{'K}$

$f_a = 1.421/2.13 = 0.667^{ksi}$

$f_{bx} = \frac{3.34 \times 12}{2.29} = 17.5^{ksi}$

conservative

$\frac{Kl}{r})_y = \frac{1.0 \times (24 + 2.625)}{0.45} = 59.2$ GOVERN $\rightarrow F_a = 17.5^{ksi}$

$\frac{Kl}{r})_x = \frac{0.65 \times 8 \times 12}{1.47} = 42.4$

$f_a/F_a = 0.667/17.5 = 0.0381 \ll 0.15$

$F_{by} = \frac{12 \times 1000}{26.625 \times 7.84} = 57.5^{ksi}$ USE $22.^{ksi}$

AISC 1.6-2

Ref to SCS-101C Set 1 Sh 182 R4

$(0.0381 + \frac{17.5}{22}) \times 1.0154 = 0.846 < 1.0$ O.K.

@ Bolt hole Location:

compare the moment (D.L.) & the properties

$\frac{0.7823^{'K} @ bolt}{1.2509^{'K} @ pt. B} = 0.6254 < \frac{1.948}{2.29} = 0.8507$ O.K.

Sx (net section) SCS-111C Set 8 Sh 37 R2

∴ Beam C4x7.25 IS ADEQUATE

F-166, 7-82

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

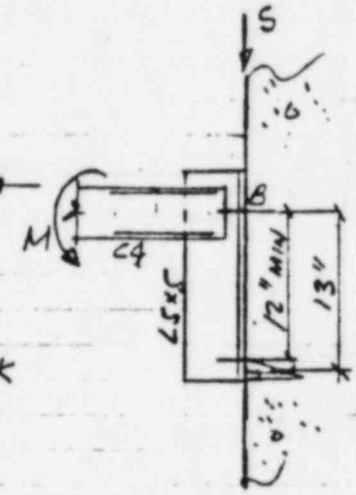
Subject CABLE TRAY SUPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 243

Revision	Original Issue	Date	Rev. 9	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			Seel	9/10/84						
Checker			mc	9-26-84						

CASE D1 (CONT)

BEAM CONN. @ WALL:



$P_a^{D.L.} = 0.051^k$; $M^{D.L.} = 1.2509^{'k}$; $S^{D.L.} = 0.7038^k$

$P_a^V = 0.085^k$ (0.051×1.67); $M^V = 2.089^{'k}$; $S^V = 1.1753^k$ (0.7038×1.67)

$P_a^T = 1.3674^k$; $M^T = 0.0317^{'k}$; $S^T = 0.0119^k$

$$T^{D.L.} = \frac{0.051 \times 10.5}{12.0} + \frac{1.2509 \times 12}{13} = 1.1993 \ ^k/\phi$$

$$T^V = 1.67\ T^{D.L.} = 2.0028 \ ^k/\phi$$

$$T^T = 1.3674 + \frac{0.0317 \times 12}{13.} = 1.397 \ ^k/\phi$$

$$\Sigma T = 1.1993 + (2.0028^2 + 1.397^2)^{1/2} = 3.641 \ ^k/\phi$$

$$\Sigma S = \left[0.7038 + (1.1753^2 + 0.0119^2)^{1/2}\right]/2 = 0.9396 \ ^k/\phi$$

1"φ × 7" EMB. H.K.B.

F.S = 4.0

$$\left(\frac{3.641 \times 1.5}{5.5} + \frac{0.9396}{5.4}\right) \times \frac{4}{5} = 0.934 < 1.0$$

Ref. SCS-101C set 5 Sh.10 REV.1 for ALLOWABLE BOLT CAPACITY.

BOLT CONN. @ WALL IS ADEQUATE

∴ SUPPORT CASE D1 IS ADEQUATE

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82