



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

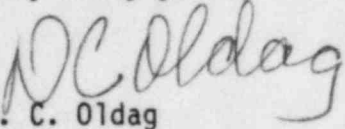
Subject: Responses to Cygna Questions from the Independent Assessment Program
Reviews
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 4
Texas Utilities Generating Company
Job No. 84056

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
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

8412120249 841128
PDR ADOCK 05000445
A PDR

2222
1/1
USE ATTACHMENT 0157.
Per S. Burwell



Mrs. Juanita Ellis
84056.038

November 28, 1984
Page 1 of 1

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. Williams (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

CTN-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

31 2/2
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

JOB NO :

DATE REC'D/LOGGED:

LOG NO.:

FILE:

CROSS REF. FILE

84056

11/12/84

42

2.1.1 2nd. CR

11.1.1 Tech. Files # 204

Dravo

C

QUESTION 1: CYGNA LETTER 84056.031 ATTACHMENT A *item 1*

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. E. H. DWG's a) 2323-EI-0700-01-S REV

- b) 2323-S-0901 REV. 4

- c) 2323-S-0903 REV.5

- d) 2323-S-0902 REV. 5

- 4) SCS-137C SET 2

JUSTIFICATION:

THE ADEQUACY OF SUP'T #202 (TYPE A4, MODIFIED PER CMC 4552.22) TO
SUPPORT VERTICAL AND TRANSVERSE LOADS IS SHOWN ON
SH. 4 R.O. 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.

100-455022-100

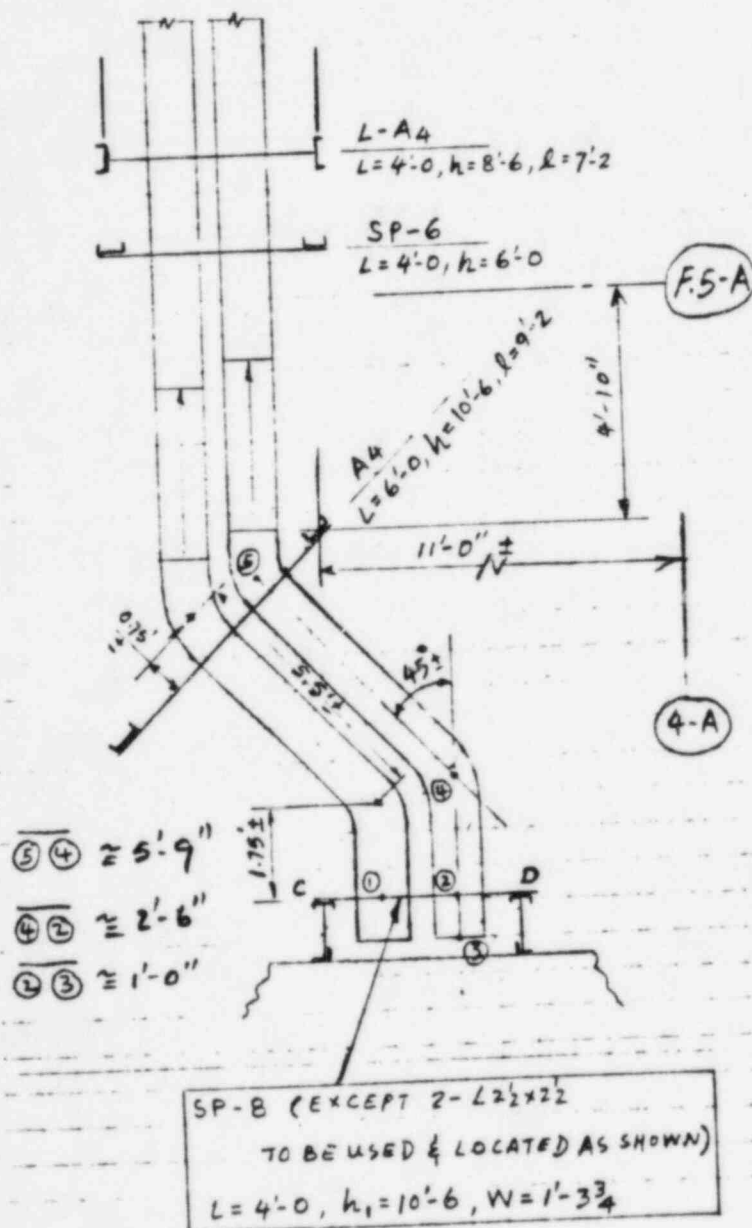
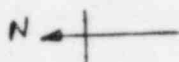
Checking Method #

- 1 Line-by-line checking
- 2 Alternative Calculation Results compared
- 3 Identical Calculation Results compared

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 | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | ML | 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)

$$\frac{1}{2} SSE; g_v = 1.48 \quad g_H = 0.71$$

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

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

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

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

F-166, 7-82

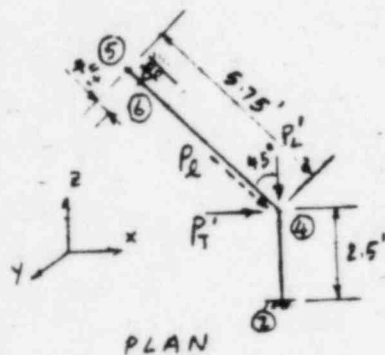
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-101C SET 3 Sheet No. 224

| Revision | Original Issue | Date | Rev. 8 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | MC | 9-8-84 | | | | | | |
| Checker | | | NV | 9-14-84 | | | | | | |

CHECK TRAY
 CRITICAL @ ②

12" TRAY - GG-12-SL-12-06 \Rightarrow $F_u = 265 \text{ #/}$
 $F_c = 424 \text{ #/}$
 $F_L = 1295 \text{ #/}$ } VENDOR INFORMATION
 SSE CONDITION:

DUE TO LONGIT'L LD.



$$P_L = 35 \times 1 \times 5.75' \times 1.03 = 208 \text{ #}$$

$$P'_L = 208 \sin 45^\circ = 147 \text{ #} = P'_T$$

$$R_{Z②}^L = 147 + 35 \times 1 \times 2.5 \times 1.03 = 238 \text{ #}$$

DUE TO TRANSV. LD.

ASSUME PINNED @ ⑥ & FIXED @ ②

$$R_{X②} \approx \frac{5}{8} \times (35 \times 1 \times 1.03) \times 7.92 + 147 \text{ #} (P'_T) = 326 \text{ #}$$

$$M_{Y②}^T \approx \frac{1}{8} \times (35 \times 1 \times 1.03) \times 7.92^2 + 147 \times 2.5 = 650 \text{ #-ft}$$

* ADD'L DUE TO P_L
 (CONSERVATIVE)

DUE TO VERT. LD

MOM. DUE TO OVERHANG @ ③, $M_{X③}^{DL} = \frac{1}{2} \times (35 \times 1) \times 1.0^2 = 18 \text{ #-ft}$

$$M_{X③}^V = 2.31 \times 18 = 42 \text{ #-ft}$$

INTERACTION: $1.6 \left[\frac{f'_n}{F_n} + \sqrt{\left(\frac{f'_n}{F_n}\right)^2 + \left(\frac{f'_c}{F_c}\right)^2 + \left(\frac{f'_L}{F_L}\right)^2} \right] \leq 1$

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

$$= 1.6 [0.0085 + \sqrt{0.0198^2 + 0.1916^2 + 0.0230^2}] = 0.329 < 1.0$$

TRAY IS O.K.

HEAVY DUTY TRAY CLAMP @ ② (REF 3d) THE ABOVE REACTIONS ARE VERY SMALL.

AND OVERHANG @ ③ 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

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. 225

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

CHECK SUPPORT #455 (SP-8) $\frac{1}{2}$ 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. $P_{E1}^L = (0.04 \times 1' \times 5.5' \times 0.71) \times \sin 45^\circ + 0.04 \times 1 \times (1.75 + 1.0) \times 0.71$
 $= 0.110 + 0.078 = 0.189^k$

TRANSV. LD. $P_{X1}^T = (0.04 \times 1' \times 5.5' \times 0.71) \times \sin 45^\circ + (0.130 + 0.04) \times 0.71$
 $= 0.110 + 0.092 + 0.028 = 0.23^k$

$M_{y1}^T = 0.110 \times 1.75 - 0.028 \times \frac{1.0}{2} = 0.179^{1-k} = 2.142^{11-k}$

@ 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. $P_{E2}^L = (0.04 \times 1 \times 5.75 \times 0.71) \times \sin 45^\circ + 0.04 \times 1 \times (2.5 + 1.0) \times 0.71$
 $= 0.115 + 0.099 = 0.214^k$

TRANSV. LD. $P_{X2}^T = (0.04 \times 1 \times 5.75 \times 0.71) \times \sin 45^\circ + (0.158 + 0.04) \times 0.71$
 $= 0.115 + 0.112 + 0.028 = 0.255^k$

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

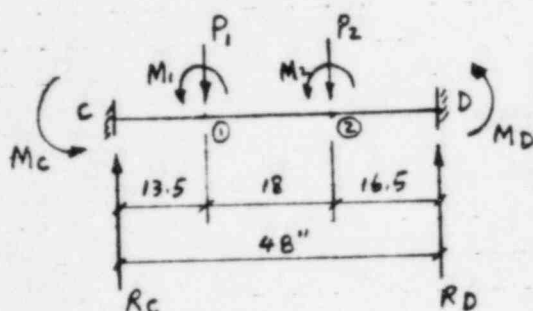
Checking Method #

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

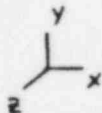
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-101C SET 3 Sheet No. 226

| Revision | Original Issue | Date | Rev. 8 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method 8 | | | 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



$$M_{zc}^{DL} = \frac{0.17 \times 13.5 \times 34.5^2}{48^2} + \frac{0.198 \times 31.5 \times 16.5^2}{48^2}$$

$$= 1.186 + 0.737 = 1.923 \text{ "K}$$

$$M_{zd}^{DL} = - \frac{0.17 \times 13.5^2 \times 34.5}{48^2} - \frac{0.198 \times 31.5^2 \times 16.5}{48^2}$$

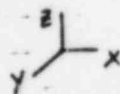
$$= -0.464 - 1.407 = -1.871 \text{ "K}$$

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

$$= 0.137 + 0.054 = 0.191 \text{ K}$$

$$R_{yd}^{DL} = 0.17 + 0.198 - 0.191 = 0.177 \text{ K}$$

DUE TO LONGIT. LD.



$$M_{yc}^L = \frac{0.189}{0.17} \times 1.186 + \frac{0.214}{0.198} \times 0.737 = 1.319 + 0.797 = 2.116 \text{ "K}$$

$$M_{yd}^L = \text{"} \times (-0.464) + \text{"} \times (-1.407) = -0.516 - 1.521 = -2.037 \text{ "K}$$

$$R_{zc}^L = \text{"} \times 0.137 + \text{"} \times 0.054 = 0.152 + 0.058 = 0.21 \text{ K}$$

$$R_{zd}^L = 0.189 + 0.214 - 0.21 = 0.193 \text{ K}$$

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

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. 227

| Revision | Original Issue | Date | Rev. 8 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | MC | 9-10-84 | | | | | | |
| Checker | | | NV | 9-14-84 | | | | | | |

DUE TO TRANSV. LD. $R_{xc}^T \cong R_{xd}^T \cong \frac{1}{2} \times (0.23 + 0.255) = 0.243^k$

$$M_{yc}^T = - \frac{2.142 \times 34.5}{48^2} (2 \times 13.5 - 34.5) - \frac{3.282 \times 16.5}{48^2} (2 \times 31.5 - 16.5)$$

$$= 0.241 - 1.093 = -0.852 \text{ H-K}$$

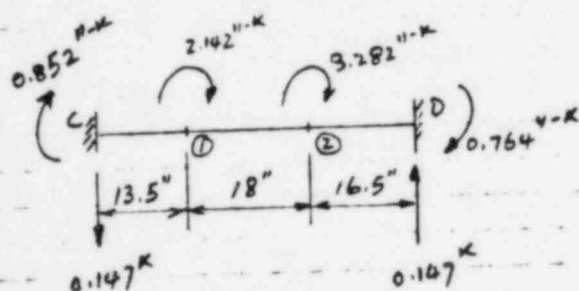
$$M_{yd}^T = - \frac{2.142 \times 13.5}{48^2} (2 \times 34.5 - 13.5) - \frac{3.282 \times 31.5}{48^2} (2 \times 16.5 - 31.5)$$

$$= -0.697 - 0.067 = -0.764 \text{ H-K}$$

$$R_{zc}^T = - \frac{6 \times 2.142 \times 13.5 \times 34.5}{48^3} - \frac{6 \times 3.282 \times 31.5 \times 16.5}{48^3}$$

$$= -0.054 - 0.093 = -0.147^k$$

$$R_{zd}^T = 0.147^k$$

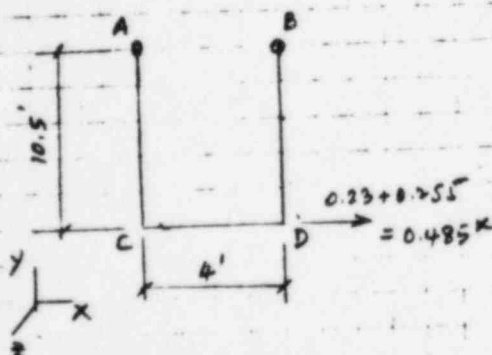


$$M_{y1}^T = 0.852 - 0.147 \times 13.5 = -1.133 \text{ H-K} \quad (+1089)$$

$$M_{y2}^T = 0.147 \times 16.5 - 0.764 = 1.662 \text{ H-K} \quad (-1620)$$

BEAM C4X7.25: $f_{by} @ C = \frac{0.852}{0.343} = 2.484 \text{ ksi}$

$f_{by} @ 2 = \frac{1.662}{0.343} = 4.845 \text{ ksi}$



$$M_{zc}^T = M_{zd}^T = \frac{0.485}{2} \times 10.5 \times 12 = 30.555 \text{ H-K}$$

$$R_{yc} = R_{yd} = \frac{0.485 \times 10.5}{4.0} = 1.273^k$$

$$f_{bz} @ C = \frac{30.555}{2.29} = 13.343 \text{ ksi}$$

$$f_{bz} @ 2 = \frac{24 - 16.5}{24} \times 13.343 = 4.170 \text{ ksi}$$

@ C; $f_b^T = 2.484 + 13.343 = 15.827 \text{ ksi} > 4.845 + 4.170 = 9.015 \text{ ksi}$

F-166, 7-82

PT. 'C' IS CRITICAL

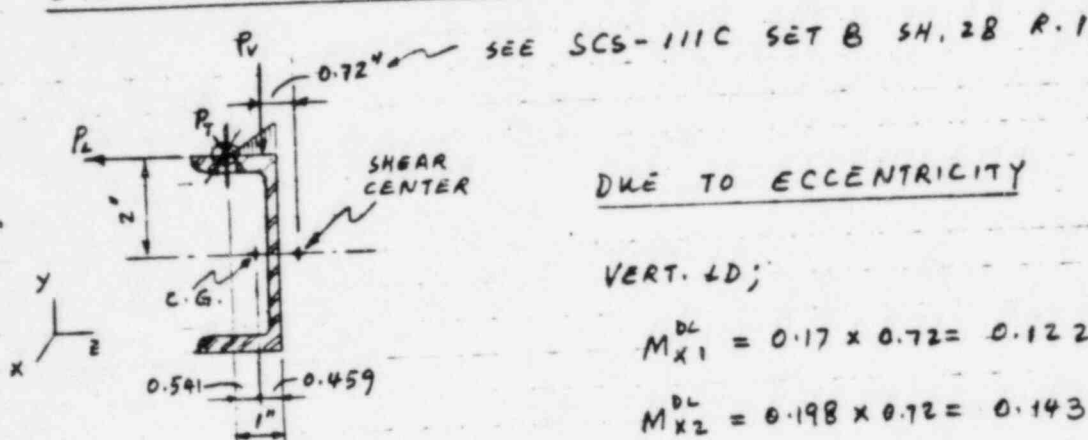
Checking Method #

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

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



DUE TO ECCENTRICITY

VERT. LD;

$$M_{x1}^{DL} = 0.17 \times 0.72 = 0.122 \text{ "K}$$

$$M_{x2}^{DL} = 0.198 \times 0.72 = 0.143 \text{ "K}$$

LONGIT. LD;

$$M_{x1}^L = 0.189 \times 2 = 0.378 \text{ "K}$$

$$M_{x2}^L = 0.214 \times 2 = 0.428 \text{ "K}$$

TRANSV. LD;

$$M_{y1}^T = 0.23 \times 0.541 = 0.124 \text{ "K}$$

$$M_{y2}^T = 0.255 \times 0.541 = 0.138 \text{ "K}$$

$$M_{z1}^T = 0.23 \times 2 = 0.46 \text{ "K}$$

$$M_{z2}^T = 0.255 \times 2 = 0.51 \text{ "K}$$

$$\Delta M_{yc}^T = \frac{0.124}{2.142} \times 0.241 - \frac{0.138}{3.282} \times 1.093 = 0.014 - 0.046 = -0.032 \text{ "K}$$

$$\Delta M_{yd}^T = " \times (-0.697) - " \times 0.067 = -0.040 - 0.003 = -0.043 \text{ "K}$$

$$\Delta R_{zc}^T = " \times (-0.054) - " \times 0.093 = -0.003 - 0.004 = -0.007 \text{ K}$$

$$\Delta R_{zd}^T = 0.007 \text{ K}$$

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

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. 229

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | WC | 9-11-84 | | | | | | |
| Checker | | | NV | 9-14-84 | | | | | | |

DUE TO ECCENTRICITY, TRANSV. LD. (CONT'D)

$$\Delta M_{2C}^T = \frac{2.0''}{0.541''} \times (-0.032) = -0.118''\text{-K}$$

$$\Delta M_{2D}^T = " \times (-0.043) = -0.159''\text{-K}$$

$$\Delta R_{YC}^T = " \times (-0.007) = -0.026\text{K} = -\Delta R_{YD}^T$$

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

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. 230

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | WC | 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':

$$\phi_c'' = \frac{0.67 M_{\textcircled{1}} + 0.26 M_{\textcircled{2}}}{11.2 \times 10^3 \times 0.082 \times 6.25} = 0.17422 \times 10^{-3} (0.67 M_{\textcircled{1}} + 0.26 M_{\textcircled{2}})$$

$$\begin{aligned} \sigma_{no} &= 29 \times 10^3 \times 1.88 \times 0.17422 \times 10^{-3} (0.67 M_{\textcircled{1}} + 0.26 M_{\textcircled{2}}) \\ &= 9.5 (0.67 M_{\textcircled{1}} + 0.26 M_{\textcircled{2}}) \end{aligned}$$

VERT. LD. $f_{bz}^{DL} = \frac{1.923}{2.29} = 0.840 \text{ ksi}$ $f_{bz}^V = 0.840 \times 1.48 = 1.243 \text{ ksi}$
 $\sigma_{no}^{DL} = 9.5 (0.67 \times 0.122 + 0.26 \times 0.143) = 1.130 \text{ ksi}$ $\sigma_{no}^V = 1.13 \times 1.48 = 1.672 \text{ ksi}$

LONGIT. LD. $f_{by}^L = \frac{2.116}{0.343} = 6.169 \text{ ksi}$
 $\sigma_{no}^L = 9.5 (0.67 \times 0.378 + 0.26 \times 0.428) = 3.463 \text{ ksi}$

TRANSV. LD. $f_a^T = \frac{0.243}{2.13} = 0.114 \text{ ksi}$ $\frac{f_a^T}{F_a} = \frac{0.114}{12.07} = 0.009 < 0.15$
 $f_{by}^T = \frac{0.852 + 0.032}{0.343} = 2.577 \text{ ksi}$
 $f_{bz}^T = \frac{30.555 + 0.118}{2.29} = 13.394 \text{ ksi}$

INTERACTION:

$$\begin{aligned} &\left(\frac{0.840 + 1.130}{22} \right)_{DL} + \left[\left(\frac{1.243 + 1.672}{22} \right)^2 + \left(\frac{6.169 + 3.463}{22} \right)^2 + \left(0.009 + \frac{2.577 + 13.394}{22} \right)^2 \right]^{1/2} \\ &= 0.090 + \left[0.133^2 + 0.438^2 + 0.735^2 \right]^{1/2} = 0.956 < 1.0 \end{aligned}$$

BEAM C4x7.25 IS ADEQUATE

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 | | | WLC | 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.

CONCLUSION:

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

F-166, 7-82

| | | | | |
|---------------|--|--------------------|-----------------------|----------------------|
| Company: | Texas Utilities | | OR Telecon | OR Conference Report |
| Project: | Comanche Peak Steam Electric Station Independent Assessment Program - Phase 4 | | Job No. | 84056 |
| Subject: | Support MS-1-002-005-S72R Local Buckling and Bending Stresses <i>MS-1-001-005-S72R</i> | | Date: | 10/4/84 |
| | | | Time: | 10:30 |
| | | | Place: | SF |
| Participants: | J. Finneran | CYGNA | of | TUGCO |
| | J. Minichiello | JOB NO : | <i>84056</i> | Cygn |
| | | DATE REC'D/LOGGED: | <i>10/18/84</i> | |
| | | LOG NO.: | <i># 37</i> | |
| | | FILE: | <i>2.1.1 Ex. CR</i> | |
| | | CROSS REF. FILE | <i>2.1 MC. CR LOG</i> | 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 MS-1-002-005-S72R and MS-1-001-005-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*

By: *N. Williams* / down Page 1 of 1
 Distribution: N. Williams, D. Wade, J. Van Amerongen, J. Minichiello, S. Treby, J. Ellis,
 S. Russell, Project File

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.

Agent For

DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Filing Code

CYGNA

84056

Sheet No.

1 of 3

G & H Job. No.

Date 10 OCT 84

Calc By

GMC

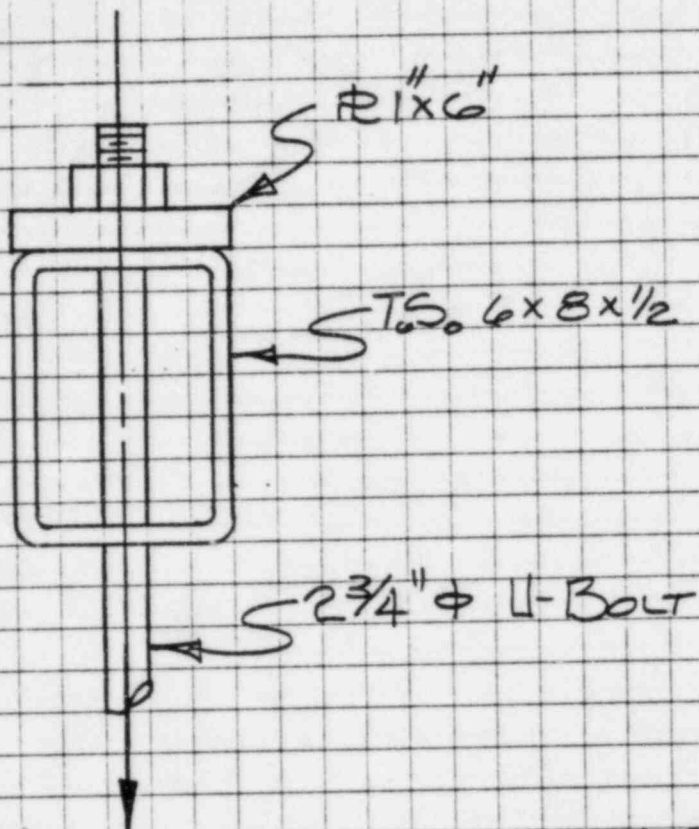
Chk'd/Approved By

VFB 10/11/84

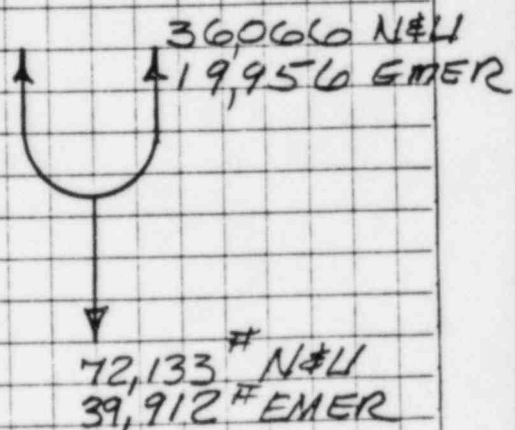
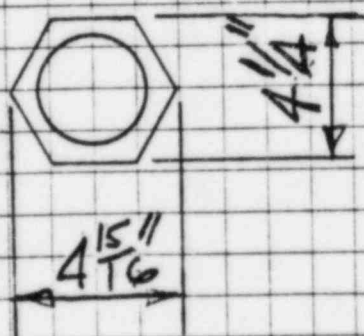
Subject

MS-1-001-005-S72R REV. 6

Ref. Dwg./Spec. No.



(1/2) - 72, 133 NORMAL #4PSET
(1/2) - 39, 912 EMERGENCY



TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.

Agent For

DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANYCYGNA
Filing Code 84056
Sheet No. 2 Of 3
G & H Job. No.

Date 10 Oct 84

Calc By GMC

Chk'd/App'd. By MM 10/12/84

Subject MS-1-001-005-S72R REV. 6 Ref. Dwg./Spec. No.

1) ACTING, PUNCHING, SHEAR

AISC
4-137
8TH EDUSE THE COLLAR DIAMETER, $4\frac{1}{4}"$, THIS
IS A VERY CONSERVATIVE ASSUMPTIONPERIMETER IS $(4\frac{1}{4}") (\pi) = 13.35 \text{ IN.}$

PUNCH'S SHEAR IN LBS. / LINEAR INCH

$$36066 \frac{\#}{\text{IN}} / 13.35 = 2702 \frac{\#}{\text{LINEAR INCH}}$$

IN N#11

PUNCHING SHEAR IN PSI

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

∴ 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:

$$Q_B = 1.21 = 0.25$$

$$\frac{(4.25)(1 - \frac{4.25}{6})}{(\frac{4.25}{6})}$$

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

TEXAS UTILITIES SERVICES INC.

COMANCHE PEAK S.E.S.

Agent For

DALLAS POWER & LIGHT COMPANY

TEXAS ELECTRIC SERVICE COMPANY

TEXAS POWER & LIGHT COMPANY

CYGNA

Filing Code 84056

Sheet No. 3 Of 3

G & H Job. No. _____

Date 10 OCT 84

Calc By GMC

Chk'd/Approved By TAD 10/11/84

Subject MS-1-001-005-572R Rev 6

Ref. Dwg./Spec. No. _____

2 CONTINUED)

$$F_y = 31.9 \text{ KSI @ } 300^\circ \text{ FOR A-36}$$

$$37.2 \text{ KSI @ } 300^\circ \text{ FOR A-500}$$

$$D = 6 \text{ INCHES}$$

$$t = \text{TUBE STEEL THK + PLATE THICK}$$

$$\text{OR } (1 + .5) = 1.5 \text{ INCH}$$

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

$$\nabla V_p \text{ CANNOT EXCEED } (.4) F_y$$

$$\sigma_o V_p \text{ ALLOWABLE IS } (.4)(31.9) = 12.76 \text{ KSI}$$

3.) COMPARE ACTING V_p WITH ALLOW. V_p

$$\frac{1806 \text{ PSI}}{12760 \text{ PSI}} = .1411 = 14\%$$

OF ALLOWABLE

- NELL CONTROLS -

TEXAS UTILITIES SERVICES INC.

COMANCHE PEAK S.E.S.

Agent For

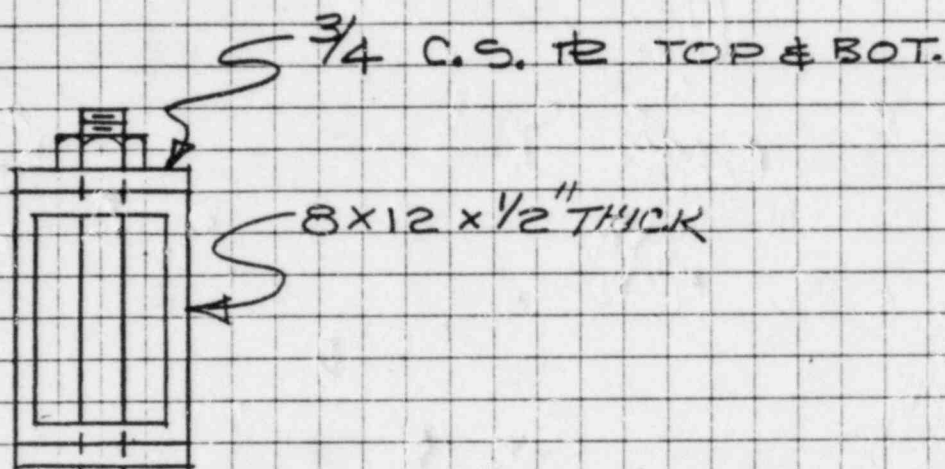
DALLAS POWER & LIGHT COMPANY

TEXAS ELECTRIC SERVICE COMPANY

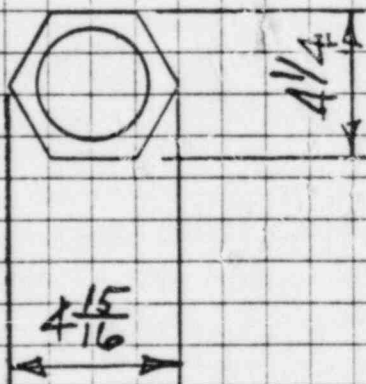
TEXAS POWER & LIGHT COMPANY

Date 10 Oct 84Calc By GMCChk'd/App'd. By 11/11/84Subject MS-1-002-005-572R REV 6 Ref. Dwg./Spec. No. _____CYGNA
Filing Code 84056 10/4/84Sheet No. 1 Of 4

G & H Job. No. _____

SA-36 - $2\frac{3}{4}$ " ϕ NORMAL & UP-SET - 73887
EMERGENCY - 42,973

NEW LOAD CONTROLS



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

CYGNA

Filing Code 84056

Sheet No. 2 of 4

C & H Job. No.

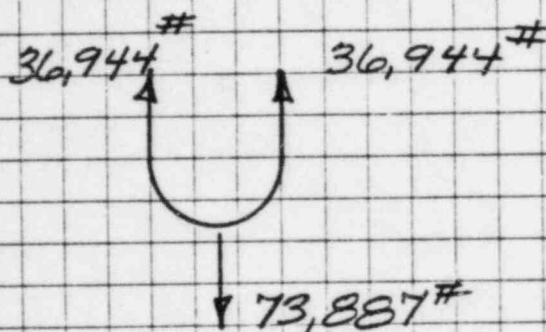
Date 10 OCT 84

Calc By GMC

Chk'd/App'd. By NFB 10/11/84

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

Ref. Dwg./Spec. No.

1.) ACTING, PUNCHING, SHEAR, V_{PA} .USE COLLAR DIAMETER OF 4.25 INCH - AISC
USING THE COLLAR DIAMETER IS
VERY CONSERVATIVE 4-137
8TH EDPERIMETER IS $(4.25)(\pi) = 13.35$ IN

PUNCHING, SHEAR IN #/LINEAR INCH

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

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

∴ 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

CYGIVA

Filing Code 84056

Sheet No. 3 of 4

G & H Job No.

Date 10 OCT 84

Calc By GMC

Chk'd/Approved By MHA 10/11/84

Subject MS-1-002-005-S72R Rev 6 Ref. Dwg./Spec. No.

2) FIND ALLOWABLE, V_p .

$$V_p = Q_B Q_F \times \left[\frac{F_y}{0.6} \left(\frac{D}{2t} \right) \right]$$

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

$Q_F = 1.00$ 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 $(.4) F_y$

$\therefore V_p = 12.76$ KSI

AWS D1.1-79
10.3 THRU 10.6

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 84Calc By GMCChk'd/App'd. By MB 10/11/84Subject MS-1-002-005-572R REV 6

CYGNA

Filing Code 84056Sheet No. 4 Of 4

G & H Job No. _____

3.) COMPARE ACTING V_p WITH ALLOWABLE V_p

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

 $17\frac{1}{3}\%$ OF ALLOWABLE - N#4 CONTROLS

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 | 2.1.2 Inc. CR Log |

Distribution:

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

84056/PP

TEXAS UTILITIES GENERATING COMPANY

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

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 |

Rec'd. 10/2/84
NHW

Distribution

R. Heed

N. Williams

J. P. Foley

P. Rainey

84056 PF

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 Division

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 CEW 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
VRD Comanche Peak Projects

J.Porterfield/jjs/0987d:1

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

1L
1L
1L
1L
1L
1L
1L
1L
1L
1L

Telephone Conversation Record

SMMA/MS-12, EH/Jir, JWM/OMi, KF, OUTGOING 048

GTN-40147 (9-24-79)

Date: 8/22/79

Time: 11:00 am

ARMS
INDEXED

Cell by: Dino Mirkovic of G&H (Company)
DATE

Answer by: Randy Crawford 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.

Bill Amma

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 | |
| | |
| | |
| | |

STRUTHERS WELLS



EXCHANGER SPECIFICATION SHEET

DESIGN

| | | | |
|--|---------------------------------|--|---------------------|
| CUSTOMER Texas Utilities Services, Inc. | | JOB NO. TUGC P.O. #CP-0049 | |
| ADDRESS Gibbs & Hill, Inc. - Agent | | REFERENCE NO. TUSI 05049 | |
| PLANT LOCATION Comanche Peak Steam Elec. Sta. - Units 1 & 2 | | ORDER NO. 1-74-06-32467 | |
| | | DATE - 05/12/76 | |
| SERVICE OF UNIT COMPONENT COOLING WATER HEAT EXCHANGER | | ITEM NO. 1.0 | |
| SIZE 61-528 | TYPE TEMA CGI | CONNECTED IN Horizontal | |
| SURFACE PER UNIT 48,720 Eff. SHELLS PER UNIT Two * | | SURFACE PER SHELL 24,360 Eff. | |
| 49,416 Gross | | 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 | 7,350,000 #/Hr. | | 7,000,000 #/Hr. |
| LIQUID | | | |
| STEAM | | | |
| NON-CONDENSABLES | | | |
| FLUID VAPORIZED OR CONDENSED | | | |
| STEAM CONDENSED | | | |
| GRAVITY—LIQUID | | | |
| VISCOSITY—LIQUID | | | |
| MOLECULAR WEIGHT—VAPORS | | | |
| SPECIFIC HEAT—LIQUIDS | 1. | B.T.U./# | 1. |
| LATENT HEAT—VAPORS | | B.T.U./# | |
| TEMPERATURE IN | 114.5 | °F | 98.4 |
| TEMPERATURE OUT | 105.0 | °F | 109.4 |
| OPERATING PRESSURE | 135 | #/SQ. IN. | 70 |
| NUMBER OF PASSES | One | | One |
| VELOCITY | 2.6 | FT./SEC. | 4.7 |
| PRESSURE DROP | 12.4 | #/SQ. IN. | 5.3 |
| CLEANLINESS FACTOR | 80.0 | | |
| HEAT EXCHANGED—B.T.U./HR. | 70,000,000 | M.T.D. (CORRECTED) | 6.4 |
| TRANSFER RATE—SERVICE | 451 | CU/LAN | 564 |
| CONSTRUCTION OF ONE SHELL | | | |
| DESIGN PRESSURE | 150 | #/SQ. IN. | 150 |
| TEST PRESSURE | 225 | #/SQ. IN. | 225 |
| DESIGN TEMPERATURE | 225 | °F | 225 |
| TUBES 90/10 Cu-Ni (B-111) NO. 2860 | O.D. 3/4" SWG. 18Min | LENGTH 44'-0" | PITCH 15/16" Tri. |
| SHELL C.S. A-516-70 | I.D. MAX 61" | THICKNESS 2Courses 1-1/8" | Remainder 1/2" |
| 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 | 3/16" | FLOATING --- | |
| BAFFLES—CROSS C.S. (3) | TYPE seg. w/ 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# P.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. | | | |

 FOR OFFICE AND
ENGINEERING USE ONLY

STRUTHERS WELLS



EXCHANGER SPECIFICATION SHEET

PERFORMANCE - INITIAL RECIRCULATION

| | | | | | |
|----|--|---|--------------------|-----------------|-------------------------------|
| 1 | CUSTOMER | Texas Utilities Services, Inc. | | JOB NO. | |
| 2 | ADDRESS | Gibbs & Hill, Inc. - Agent | | REFERENCE NO. | TUSI 05049 |
| 3 | PLANT LOCATION | Comanche Peak Steam Elec.Sta.-Units 1 & 2 | | PROPOSAL NO. | 7367-N6 |
| 4 | | | | DATE | 6/12/74 |
| 5 | SERVICE OF UNIT COMPONENT | COOLING WATER HEAT EXCHANGER | | ITEM NO. | 1.0 |
| 6 | SIZE | 61-528 | TYPE | TEMA CGN | CONNECTED IN Horizontal |
| 7 | SURFACE PER UNIT | 48,720 Eff. | SHELLS PER UNIT | Two * | SURFACE PER SHELL 24,359 Eff. |
| 8 | | 29,416 Gross | | | 24,708 Gross |
| 9 | *Del. 3/1/76 (two units) | | | | |
| 10 | PERFORMANCE OF ONE UNIT | | | | |
| 11 | | SHELL SIDE | | TUBE SIDE | |
| 12 | FLUID CIRCULATED | COOLING WATER | | SERVICE WATER | |
| 13 | TOTAL FLUID ENTERING | 7,350,000 #/Hr. | | 7,000,000 #/Hr. | |
| 14 | VAPOR | | | | |
| 15 | LIQUID | 7,350,000 #/Hr. | | 7,000,000 #/Hr. | |
| 16 | STEAM | | | | |
| 17 | NON-CONDENSABLES | | | | |
| 18 | FLUID VAPORIZED OR CONDENSED | | | | |
| 19 | STEAM CONDENSED | | | | |
| 20 | GRAVITY—LIQUID | | | | |
| 21 | VISCOSITY—LIQUID | | | | |
| 22 | MOLECULAR WEIGHT—VAPORS | | | | |
| 23 | SPECIFIC HEAT—LIQUIDS | 1. | B.T.U./# | 1. | B.T.U./# |
| 24 | LATENT HEAT—VAPORS | | B.T.U./# | | B.T.U./# |
| 25 | TEMPERATURE IN | 170.5 | °F | 95.0 | °F |
| 26 | TEMPERATURE OUT | 135.0 | °F | 132.0 | °F |
| 27 | OPERATING PRESSURE | 135 | #/SQ. IN. | 70 | #/SQ. IN. |
| 28 | NUMBER OF PASSES | One | | One | |
| 29 | VELOCITY | 2.6 | FT./SEC. | 4.8 | FT./SEC. |
| 30 | PRESSURE DROP | 12.4 | #/SQ. IN. | 5.3 | #/SQ. IN. |
| 31 | CLEANLINESS FACTOR | ----- 80.0% ----- | | | |
| 32 | HEAT EXCHANGED—B.T.U./HR. | 260,000,000 | M.T.D. (CORRECTED) | 39.2 | |
| 33 | TRANSFER RATE—SERVICE | 272 | CLEAN | 340 | |
| 34 | CONSTRUCTION OF ONE SHELL | | | | |
| 35 | DESIGN PRESSURE | | #/SQ. IN. | | #/SQ. IN. |
| 36 | TEST PRESSURE | | #/SQ. IN. | | #/SQ. IN. |
| 37 | DESIGN TEMPERATURE | | °F | | °F |
| 38 | TUBES | NO. | O.D. | SWG. | LENGTH |
| 39 | SHELL | | I.D. | O.D. | THICKNESS |
| 40 | SHELL COVER | | | | FLOATING HEAD COVER |
| 41 | CHANNEL | | | | CHANNEL COVER |
| 42 | TUBE SHEETS—STATIONARY | | | | FLOATING |
| 43 | BAFFLES—CROSS | | TYPE | | THICKNESS |
| 44 | BAFFLE—LONG | | TYPE | | THICKNESS |
| 45 | TUBE SUPPORTS | | | | THICKNESS |
| 46 | GASKETS | | | | |
| 47 | CONNECTIONS—SHELL—IN | | OUT | | SERIES |
| 48 | CHANNEL—IN | | OUT | | SERIES |
| 49 | CORROSION ALLOWANCE—SHELL SIDE | | | | TUBE SIDE |
| 50 | CODE REQUIREMENTS | | | | |
| 51 | WEIGHTS—EACH SHELL | | BUNDLE | | FULL OF WATER |
| 52 | NOTE: INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R) | | | | |
| 53 | REMARKS: | | | | |

O/R

HYAC



EXCHANGER SPECIFICATION SHEET

| | | | |
|---|-----------------|--------------------------------|-------------------------------------|
| 1 | | EG NO | 270CIN76R2 |
| 2 | CUSTOMER | CVI Corp. | JOB NO. 17748M |
| 3 | USER | Texas Utilities Generating Co. | CUST. NO 77-1609 |
| 4 | PLANT LOCATION | Comanche Peak Nuclear Plant | DATE 9/25/78 |
| 5 | SERVICE OF UNIT | R-12 Condenser | ITEM NO. -- |
| 6 | SIZE | 16-5-102 | TYPE BEM |
| 7 | SURF. UNIT | 1170 | SO FT. SHELLS UNIT One |
| 8 | NO. OF UNITS | 4 | SHELL ARRANGEMENT --- ENGR. SPN/GAE |

PERFORMANCE OF ONE UNIT

| 9 | FLUID ALLOCATION | | SHELL SIDE | | TUBE SIDE |
|----|-------------------------------------|------------------|------------|----------------------|-----------------|
| 10 | FLUID CIRCULATED | | R-12 | | Cooling Water |
| 11 | TOTAL FLUID ENTERING | #/HR | 23,784 | | 125,000 |
| 12 | | | IN | OUT | IN |
| 13 | VAPOR | #/HR | 23,784 | -- | -- |
| 14 | LIQUID | #/HR | -- | -- | 125,000 |
| 15 | STEAM | #/HR | -- | -- | -- |
| 16 | NONCONDENSIBLES | #/HR | -- | -- | -- |
| 17 | FLUID XXXXXXXXXX CONDENSED | #/HR | -- | 23,784 | -- |
| 18 | STEAM CONDENSED | #/HR | -- | -- | -- |
| 19 | DENSITY - LIQUID | | -- | -- | 1.0 |
| 20 | VISCOSITY - LIQUID | Cps. | -- | -- | .47 |
| 21 | MOLECULAR WEIGHT - VAPORS | | 120.9 | -- | -- |
| 22 | MOLECULAR WEIGHT - NON-CONDENSIBLES | | -- | -- | -- |
| 23 | SPECIFIC HEAT | Btu/lb °F | -- | -- | 1.0 |
| 24 | THERMAL CONDUCTIVITY | | -- | -- | .38 |
| 25 | LATENT HEAT | | -- | -- | -- |
| 26 | TEMPERATURE | °F | 195 | 147 | 135 |
| 27 | INLET PRESSURE | PSIA | | 270.4 | 150 |
| 28 | NUMBER OF PASSES | PER SHELL | | One | Two |
| 29 | VELOCITY | FT/SEC | | --- | 4.8 |
| 30 | PRESSURE DROP - ALLOW/CALC | PSI | | 6 2 | 5 4.6 |
| 31 | FOULING RESISTANCE | | | --- | .0005 |
| 32 | HEAT EXCHANGED | 1,362,000 Btu/hr | | BTU/HR MTD CORRECTED | 17.5 |
| 33 | TRANSFER RATE SERVICE | 66.5 | | CLEAN --- | BTU/HR SQ FT °F |

CONSTRUCTION OF ONE SHELL

SKETCH BUNDLE NOZZLE ORIENT

| 34 | | SHELL SIDE | TUBE SIDE | |
|----|---------------------------|--|------------------------|-------------------------------|
| 35 | DESIGN TEST PRESSURE PSIG | 350 | 525 | 150 225 |
| 36 | DESIGN TEMPERATURE °F | 200 | | 200 |
| 37 | CORROSION ALLOWANCE IN | 1/8" on C/S | 1/8" on C/S | |
| 38 | CONNECTIONS | IN | 2"-3000#SW 3" 150# RF | |
| 39 | SIZE 3 | OUT | 2"-3000#SW 3" 150# RF | |
| 40 | RATING | | | |
| 41 | TUBE NO 260 | OD 5/8 | IN | THK MIN .049 IN |
| 42 | TUBE MATERIAL (XXX SMLS) | SB-359 90/10CuNi | PITCH 25/32 | IN 1/2 20XXXXXXXXXXXXXXXXXX |
| 43 | SHELL | SA-106 Gr.B | OD 16 IN | SHELL COVER --- UNITS - REMOV |
| 44 | XXXXXX BONNET | SA-106 Gr.B/SA-285Gr.C | CHANNEL COVER --- | |
| 45 | TUBESHEET - STATIONARY | SA-171 CDA 706 | TUBESHEET - FLOATING | --- |
| 46 | FLOATING HEAD COVER | --- | IMPINGEMENT PROTECTION | SA-240 304 S/S |
| 47 | BAFFLES - CROSS | SA-285 Gr.C | 4-Segm. | CUT 25 SPACING 4" |
| 48 | BAFFLES - XXXX | Subcooling weir | SA-285 | SUPPORTS SA-285 Gr.C |
| 49 | TUBE SHEET JOINTS - SHELL | Welded | 2"-Gr.C | Flanged |
| 50 | GASKETS - SHELL | --- | FLOATING HEAD | --- |
| 51 | CODE REQUIREMENTS | * | | TEMA CLASS B |
| 52 | WEIGHTS SHELL - SHIPPING | | FLOODED | LBS |
| 53 | REMARKS | *ASME Sect. III, Class 3 (Tubeside)/Section VIII, Div. 1 | | |
| 54 | | (Shellside). 1974 Edition-Winter 1976 Addenda | | |
| 55 | | Tubes per SB-359 90/10 Cu.Ni. CDA 706 Code Case 1634-1 | | |
| | | Tubes have 26 fins per inch. | | |

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SUBJECT TO COMPLIANCE WITH
ALL CONTRACT REQUIREMENTS,
DRAWINGS, AND SPECIFICATIONS.

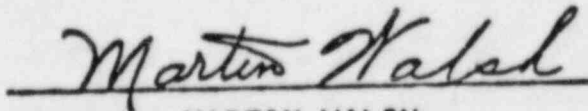
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GIBBS & HILL, INC.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

PERFORMANCE CURVE
AND
CORRECTION CURVE
FOR
CONTAINMENT SPRAY HEAT EXCHANGERS

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

BY



MARTIN WALSH
PROJECT ENGINEER
JOSEPH OAT CORPORATION

REPORT #TM-214

PROCESS DATA

| | | COLD SHELL SIDE | HOT TUBE SIDE |
|---|-----------------------------|-----------------|----------------|
| 1 NAME OF FLUID | | COM.COCL.WTR | ROTATED WTR |
| 2 FLUID CONDITION | | SENS. LIQUID | SENS. LIQUID |
| 3 TOTAL FLOW RATE | (M-LB/HR) | 3043.483 | 2903.322 |
| 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-FT ² -F) | 451.84 (1.80) | 1932.43 (1.80) |
| 10 FOULING RESISTANCE | (HM-FT ² -F/HTU) | -0.00000 | -0.00000 |
| 11 DENSITY | (LB/FT ³) | 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) | 61.21 .83 (1.00) |
| 18 OVERALL COEF. REQUIRED | (BTU/HR-FT ² -F) | 577.13 |
| 19 OVERALL COEF. CLEAN/ACTUAL | (BTU/HR-FT ² -F) | 574.16 / 574.16 |

CONSTRUCTION INFORMATION

| | | |
|-----------------------------------|--|--------|
| 20 NO. SHELLS SERIES 1 PARALLEL 1 | TOTAL SURF. AREA (FT ² /UNIT) | 5866 |
| 21 NO. PASSES SHELL 1 TUBES 2 | EFF. SURF. AREA (FT ² /SHELL) | 5780.9 |
| 22 SHELL DIAMETER (IN) 43.000 | T.E.M.A. SHELL TYPE E HEAD | UT |
| 23 BAFFLE TYPE -HORIZ-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 | HAFF.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) .825 | 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 (ROTH) | 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)

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 H = .783 |
| 4 A = .10 H = .740 C = .10 IE = .06 F = 0.00 | |
| 5 TOTAL HEAT TRANSFER CORRECTIONS | |
| 6 .920 .920 1.000 1.021 1.000 | |

PRESSURE DROPS (PCT. TOTAL SHELL DP)

| | |
|------------------------------------|------------------|
| 7 NOZZ (IN/OUT) | 6.95 / 7.03 |
| 8 END 24.64/TUBE NOZZ DP-PCT. TOT. | 8.18 9.09 |
| 9 WALL CORRECTION | 1.027 1.981 |
| 10 PRANDTL NO. | 3.0 1.9 |
| 11 REYNOLDS NO. AVG. | 42660 155992 |
| 12 REYNOLDS NO. IN. RUN. | 33105 184832 |
| 13 REYNOLDS NO. OUT. RUN. | 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 | -0.000009 |

SHELL NOZZLE INFO.

| | |
|----------------------------------|---------------|
| 19 NOZZLE I.D. (IN) | 17.3 17.3 |
| 20 VELOCITY (FT/SEC) | 8.45 8.58 |
| 21 DENSITY (LB/FT ³) | 61.682 60.731 |
| 22 NOZZ.R-V-50 (LB/FT-S2) | 4399 4468 |
| 23 BUND.R-V-50 (LB/FT-S2) | 1144 1162 |
| 24 HEIGHT UNDER NOZZ (IN) | 8.5 8.5 |

TUBE NOZZLE INFO.

| | |
|----------------------------------|---------------|
| 25 NOZZLE I.D. (IN) | 15.3 15.3 |
| 26 VELOCITY (FT/SEC) | 10.71 10.48 |
| 27 DENSITY (LB/FT ³) | 59.344 60.653 |

DIAMETRAL CLEARANCES

| | |
|---------------------------------|-------|
| 28 BAFFLE TO SHELL (IN) | .1875 |
| 29 BUNDLE TO SHELL (IN) | .0000 |
| 30 TUBE TO BAFFLE HOLE (IN) | .0156 |
| 31 BAFF.OVERLAP MULTI-SEG. (IN) | .0000 |

WPT-2729

HEAT EXCHANGER DATA SHEET

| | | | | | |
|---|-----------|-------------------------------|-------------------------|--|-----------|
| SERVICE <u>Residual Heat Exchanger RHAHRS</u> | | IDENT. <u>RS-681</u> | | JOB <u>J-2300-1</u> | |
| TYPE <u>BEU Vertical</u> | | SQ. FT. PER SHELL <u>6627</u> | | SHELLS. IN SERIES/PARAL. <u>1</u> | |
| SIZE <u>43-271</u> | | SQ. FT. PER UNIT <u>6627</u> | | TEMA CLASS <u>R</u> | |
| PERFORMANCE OF UNIT | | | | | |
| OPERATION MODE | | DESIGN | | | |
| HEAT EXCHANGED, BTU/HR | | 39.1×10^6 | | | |
| LMTD (FACTOR) ΔT | | 19.1(.89)1.0=17. | | | |
| OVERALL COEF., CLEAN/SERVICE BTU x HR ⁻¹ x FT ⁻² | | 527.5/364.8 | | | |
| | | SHELL SIDE | TUBE SIDE | SHELL SIDE | TUBE SIDE |
| FLUID ENTERING | | SERVICE WTR/PROCESS WTR | | | |
| TOTAL FLUID, LB/HR | | 3.8×10^6 | | | |
| LIQUID, LB/HR | | 3.8×10^6 | | | |
| 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 | | 400 | |
| ASME CODE CLASS | | Section III Class 3 | | Section III Class 2 | |
| CONNECTIONS | | IN 24" 150# WNRF Flange | | 12" Sch x STG Butt Weld | |
| (SIZE & FACING) | | OUT 24" 150# WNRF Flange | | 12" Sch x STG Butt Weld | |
| 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" <input checked="" type="checkbox"/> <input type="checkbox"/> | |
| BAFFLES CROSS TYPE Triple Sgmrl. | | 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 | 4-5 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 | APRD |
|----|----------------|----------|--------|--------|
| 1 | Initial Design | 9/16/76 | Rayner | Chhina |
| 2 | Revised | 11/12/76 | Rayner | Chhina |

62F-11163



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NUCLEAR EQUIPMENT

INCORPORATED
P.O. BOX 2138, COLUMBUS, OHIO 43216 • (614) 875-7381 • TELEX 246-38

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CPX-VAA CUP-02

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FOR USE AT

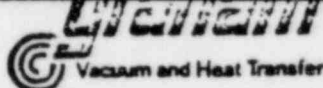
COMANCHE PEAK NUCLEAR STATION - UNITS 1 & 2
GLEN ROSE, TEXAS

CVI WORK ORDER C581

FOR OFFICE AND
ENGINEERING USE ONLY

AUGUST 1982

UPS



EXCHANGER SPECIFICATION SHEET

| | | |
|---|-----------------|--|
| 1 | EG NO. | 145-CIN-81-R1 |
| 2 | CUSTOMER | CVI Corporation |
| 3 | USER | |
| 4 | PLANT LOCATION | |
| 5 | SERVICE OF UNIT | R-12 Condenser |
| 6 | SIZE | 16-5-76 TYPE BEM |
| 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

| FLUID ALLOCATION | | SHELL SIDE | | TUBE SIDE | |
|------------------|---------------------------------------|---------------|------------------------|----------------|-----------------|
| 9 | FLUID CIRCULATED | R-12 | | Water | |
| 10 | TOTAL FLUID ENTERING | #/HR | 8016 | 45,000 | |
| 11 | | IN | OUT | IN | OUT |
| 12 | VAPOR | #/HR | 8,016 | | |
| 13 | LIQUID | #/HR | | 45,000 | |
| 14 | STEAM | #/HR | | | |
| 15 | NONCONDENSABLES | #/HR | | | |
| 16 | FLUID VAPORIZED/CONDENSED | #/HR | 8,016 | | |
| 17 | STEAM CONDENSED | #/HR | | | |
| 18 | GRAVITY - LIQUID | | | 50 | |
| 19 | VISCOSITY - LIQUID | | | 17 | |
| 20 | MOLECULAR WEIGHT - VAPORS | | | | |
| 21 | MOLECULAR WEIGHT - NON - CONDENSIBLES | | | | |
| 22 | SPECIFIC HEAT | BTU/LB°F | | 1.0 | |
| 23 | THERMAL CONDUCTIVITY | | | 58 | |
| 24 | LATENT HEAT | | | | |
| 25 | TEMPERATURE | TSAT = 150 °F | 190 145 | 135 | 146.2 |
| 26 | INLET PRESSURE | | 250 PSIA | --- | |
| 27 | NUMBER OF PASSES | PER SHELL | One | Four | |
| 28 | VELOCITY | FT/SEC | --- | 3.6 | |
| 29 | PRESSURE DROP - ALLOW/CALC | PSI | --- 1.0 | --- 3.5 | |
| 30 | FOULING RESISTANCE | | --- | .0005 | |
| 31 | HEAT EXCHANGED | 506,000 | BTU/HR MTD (CORRECTED) | Avg'd. 10.6 °F | |
| 32 | 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 | DESIGN/TEST PRESSURE PSIG | 350 / code | 150 / code |
| 35 | DESIGN TEMPERATURE °F | 200 | 200 |
| 36 | CORROSION ALLOWANCE IN | 1/8" | 1/8" |
| 37 | CONNECTIONS | IN 1-1/2" | 2" |
| 38 | SIZE & | OUT 1-1/2" | 2" |
| 39 | RATING | 3,000 lbs. SW | 150 lb. R.F. |
| 40 | TUBE NO | 250 | OD 5/8 IN THK (MIN/AVG) .049 IN LENGTH 6'4" |
| 41 | TUBE MATERIAL (WLD/SMLS) | SB359 CDA706* | PITCH 25/32 IN 30 |
| 42 | SHELL | C/S | ID 15-1/4" 16 IN SHELL COVER -- (INTEG) (REMOV) |
| 43 | CHANNEL COVER | C/S | CHANNEL COVER -- |
| 44 | TUBESHEET - STATIONARY | SB171 CDA706 (90-10) | TUBESHEET - FLOATING -- |
| 45 | FLOATING HEAD COVER | -- | IMPINGEMENT PROTECTION Yes |
| 46 | BAFFLES - CROSS | C/S TYPE Segmental | % CUT -- SPACING -- |
| 47 | BAFFLES - LONG | -- | TUBE SUPPORTS -- |
| 48 | TUBE SHEET JOINTS - SHELL | Welded | CHANNEL Flanged TUBES Rolled and Welded |
| 49 | GASKETS - SHELL | -- | FLOATING HEAD -- CHANNEL Neoprene |
| 50 | CODE REQUIREMENTS | Tube side ASME Sec III C1.3/shell side ASME | 11 MA CLASS "R" LDC |
| 51 | WEIGHTS/SHELL - SHIPPING | -- | FLOUDED Sec. VIII |
| 52 | REMARKS | *Tubes per SB359 90-10 Cuff Code Case N-68. Tubes are Wolverine | |
| 53 | | 26 FPI. | |
| 54 | | C581-9907 Page 3 of 5 | |
| 55 | | Rev N7C | |

FOR OFFICE AND
ENGINEERING USE ONLY

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 FALSIFICATION
SUBJECT TO COMPLIANCE WITH
ALL CONTRACT REQUIREMENTS,
REVISES, AND SPECIFICATIONS.

UNIT IDENTIFICATION: WATER CHILLER ITEM NUMBER
CP2-CHCICE-06 *
YORK SERIAL NUMBER 8-1965 JUL 20 1979
YORK ORDER NUMBER 77-780931(H)

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

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

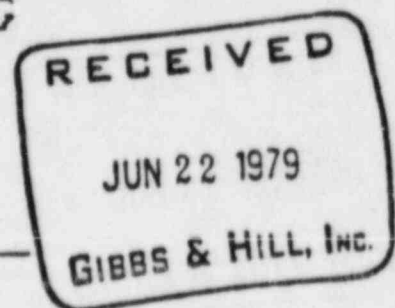
PREPARED BY:

A. R. Shanko, Jr.
A. R. SHANKO, JR.
CONTRACT ENGINEER

APPROVED BY:

R. E. Dolheimer
R. E. DOLHEIMER
CHIEF CONTRACT ENGINEER

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



AS

CUSTOMER COMANCHE PEAK STEAM ELECTRIC STATION S.O. No. 77-780931(H)PRINCIPAL EQUIPMENT UNDER TEST HTC2A1-ABCS R-11 HERMETIC TURBOPAKDATA RECORDED BY (SEE BELOW)ENGINEER A.R. SHANKO, JR.

TEST REQUEST NO. —

YORK DIVISION

BORG-WARNER CORPORATION

ENGINEERING DEPARTMENT

| 1979 | | AMBIENT | | | | EVAPORATOR | | | | | | CONDENSER | | | | | | COMPRESSOR | | | | | | OIL COOLER | | |
|--------------------------------------|------|--------------|----|------------------|---------------|------------|-------------|------------------------------|-------------------------------|-------------------------------|-----------------------|----------------------|---------------|---------|-------------|------------------------------|-------------------------------|-------------------------------|------------------------|---------------------|----------------------|-----------------------|---------------------|-------------|-----------------|------------------|
| TIME | | WIND PSIA | °F | °F | FLOW METER | CP S | G P M | H ₂ O ON °F | H ₂ O OFF °F | H ₂ O AP PSI | EVAP. PRES. "Hg | EVAP. TEMP. °F | FLOW METER | CP S | G P M | H ₂ O ON °F | H ₂ O OFF °F | H ₂ O AP PSI | COND. PRES. PSIG | LIQ. TEMP. °F | SUCT. TEMP. °F | DISCH. TEMP. °F | OIL PRES. PSI | VALVES % | OIL IN °F | OIL OUT °F |
| Date | Hour | 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 | 634-2 | | | | #1 | PANEL | | DIGITAL 579-1 | 579-2 | | | | DIGITAL 579-2 | 624-1 | 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 | | 105 | | 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 |
| | | | | | | | | | | | | | | | 15 FT. | | | | | | | | | | 12.7 FT. | |

ENGINEERING LABORATORY TEST RECORD SHEET A

YORK OPERATORS:

J. R. Shanko

R. J. Shanko

WITNESSED BY:

J. R. Shanko

R. J. Shanko

Contract Engt.

Quality Assurance

6-18-79

AT, 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 1978

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

TURBOPAK MODEL NO HTC2A1-ABCS

UNIT DUTY

101 TH

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 | 13.09 |

TUBE MATL & NO.
EXT SURF - SQ FT
DWP - WATER SIDE

COPPER - 184
1623. (26 FPI)
150 PSIG

COPPER - 163
1438. (26 FPI)
150 PSIG

COMPR MODEL A1

SPEED CODE LN

REFR 11

1" H₂O
CHILLER

SAT, DEC 11 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 <u>A1</u> | SPEED CODE <u>LA</u> | REFR <u>11</u> |
|-----------------------|----------------------|----------------|

Nuclear boiler

10. JENNY

Gibbs & Hill, Inc.

Job No.

Client

Subject

Calculation Number

Sheet No.

| Revision | Original | Date | Rev. | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|----------|----------|------|------|------|------|------|------|------|------|------|
| Design | | | | | | | | | | |
| Checker | | | | | | | | | | |

VENDOR ACCEPTED CCW Temperatures:

| EQUIPMENT EXPERIENCING LOCAL CONDITIONS | DESIGN TEMP. °F | NORMAL OPER. IN/OUT CENT. TEMP. °F | EMERGENCY OPER. IN/OUT CENT. 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 | EQUIPMENT DESIGN MANUAL |
| CT. PUMP SEAL COOLER | 200 | --- | --- | GTN-40197 |
| CT. HX. | 200 | 115/171 | *NC-CT-6 | REPORT TM. 214 C.R. CTO |
| RH PUMP SEAL COOLER | | 105/ | Info do 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 w: NC-CT-6 uses CCW temp of 135°F.

Checking Method #

1. List by line checking
2. All calculations are compared
3. All calculations are checked by a second person
4. Compare reports and see that all calculations are correct and results of similar results

F-166, 7-82

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 63B, 3026

Distribution

N. Williams

J Russ

W Horstman

84056 Project File

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, 1.6-1b and 1.6-2 are applicable.

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

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

Support 3026 is specified as a "Case SP-4, omit brace" in reference 3. The tray assembly drawing (drawing FSE-00159, sheet 3026, revision 5) specifies a brace. Cygna's walkdown indicates that a brace has not been installed and that support 3026 was located at a tray elbow. Cygna's walkdown also noted that the tray segments T12BABC15 and T12BABC16 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 T12BABC15 and T12BABC16.

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:

- For longitudinal and transverse loads (in the plane A frame)
- (a) 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 $\frac{1}{4} \times 8$ ft 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:

$$F_{by} = F_{by} \times \left[1 - \left(\frac{F_A}{F_{Ax}} \right)^2 - \left(\frac{F_{Bx}}{F_{Bx}} \right)^2 \right]^{1/2}$$

Where $F_A = 12.07 \text{ ksi}$ for $KL/r = \frac{4 \times 12}{.45} = 107$

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

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

- (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 negligible.

- (e) Inadvertently P was compared with F_a instead of $F_a \times A$. However, since A is greater than 1 ($A = 2.11 \text{ in.}^2$), 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

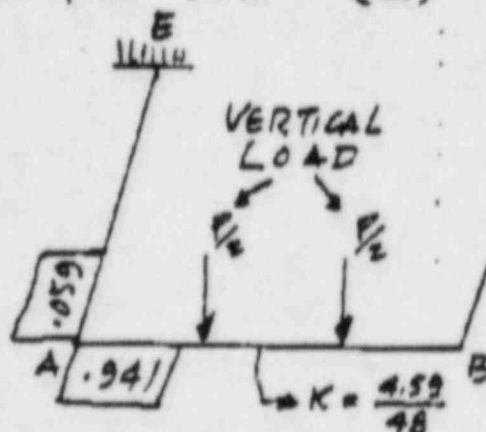
$$T = [2.69^2 + .16^2]^{1/2} = 2.694K$$

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

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



$$K = \frac{.432}{72}$$

DISTRIBUTION FACTOR

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

$$F_2 = .059$$

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

$$f_{b1} = \frac{Q \times T}{d \times S} = \tanh \frac{L}{a} \text{ WHERE } Q = 6.25 \text{ IN; } d = 4 \text{ IN; } S = 1343 \frac{1}{2} \text{ IN}^3; L = 72 \text{ IN}$$

$$f_{b1} = \frac{6.25 \times .6195 \times \frac{6}{8} \times 12 \times .059}{4 \times 1343 \frac{1}{2}} = \tanh \frac{72}{6.25} = 2.95 \text{ KSI TOTAL STRESS ON MEMBER}$$

$$f_b = 2.95 + 1348 \times \frac{5.5}{6} = 20.8 \text{ KSI WHERE } 1348 \text{ TAKEN FROM SCS-101C SH. 3/94}$$

AND REDUCED $\frac{5.5}{6}$ TIMES BECAUSE OF L G G CONNECTION ANGLE

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

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

TUGCO NUCLEAR ENGINEERING - CPSES

CALCULATION SHEET

Subject _____ Sheet _____ of _____
 Originator E.K. Date 8/3.84
 Checker _____ Date _____
 Calculation No. _____ Revision _____ Checking Method No. _____

SH. 2/2a

| 8 | 9 | 10 | 11 |
|--------------------------|--------------|-------------|----------------|
| $\frac{D}{T_{DY}}$ (KSI) | M_Y (K-10) | P_L (KSI) | 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 |

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~.

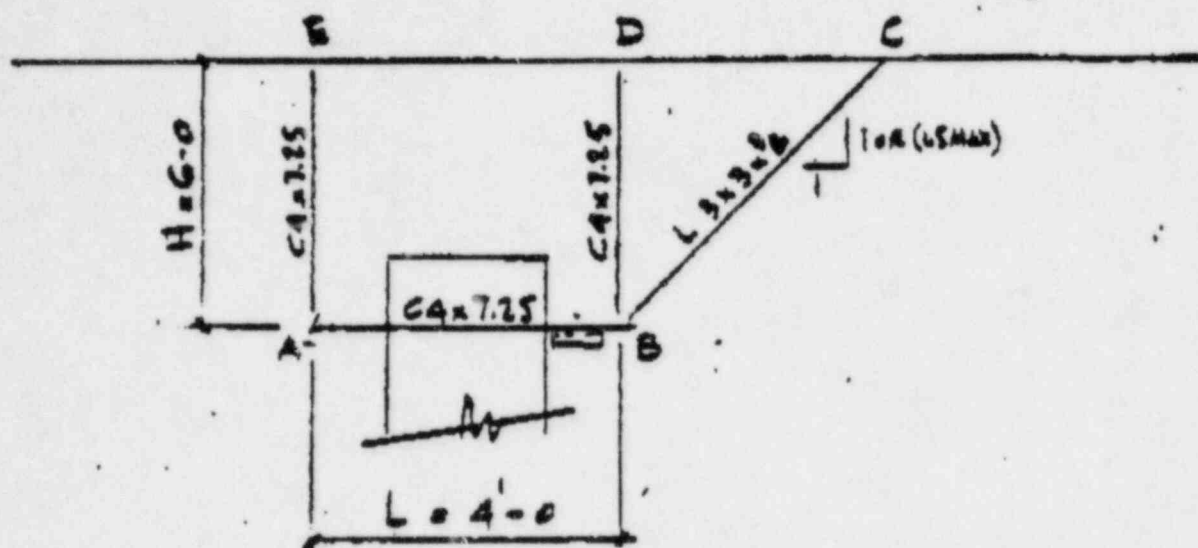
| 8 | 9 | 10 | 11 |
|-------------|----------------|--------------|----------------|
| f_y (KSI) | M_y (Kip-ft) | P_c (Kips) | L_{max} (ft) |
| 21.8392 | .6242 | 1.6646 | 41.72 |
| 21.8239 | .6238 | 1.6635 | 29.70 |
| 21.7902 | .6228 | 1.6609 | 18.98 |
| 21.7722 | .6223 | 1.6595 | 13.78 |
| 21.7390 | .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 |

Date 11/9/78
 Calc By. ENGINEER
 Check/Approved By. [Signature]
 Subject SP-3

Gibbs & Hill, Inc.
 STRUCTURAL STEELWORK CONSTRUCTORS
 NEW YORK

File No. 101C
 Sheet No. 3/91
 S & H Job No. 3323
 S-2303

TYPE SUPPORT



MEMBER AB:

CONSIDERED FIXED AT THE ENDS
 AND COMPUTATION MADE FOR VARIOUS
 G VALUE GIVEN FOR PARTICULAR ELEVATION
 FOR EACH BUILDING. ✓

CASE 1:

ONE FT. TRAY SUPPORTED AT MIDSPAN

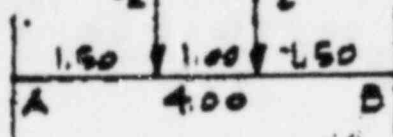
CASE 2:

TWO FT. TRAY SUPPORTED AT MIDSPAN

FOR BOTH CASES ASSUMED 8 FT SPAN FOR VERTICAL
 AND TRANSVERSE LOAD AND MADE INVESTIGATION
 TO FIND OUT L_{MAX} FOR LONGITUDINAL
 LOAD WHICH SATISFY FORMULA: ✓

$$\frac{D}{F P^2} \cdot \frac{P^2}{L^2} \cdot \frac{L^2}{2.7} \cdot \frac{1}{n n v c 1}$$

CASE 1:



$$M = 46875 P$$

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|-------|-------|-------|-------|-------|-------|----------|----------|-------|--------|-----------|
| G_v | G_H | P_v | P_H | M_x | f_a | f_{bx} | f_{by} | M_y | P_L | L_{MAX} |
| 2.40 | .57 | .672 | .1596 | .315 | .0749 | 1.6507 | 21.9379 | .6271 | 1.3378 | 67.06 |
| 2.50 | .60 | .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 | .866 | .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. $P_H = .035 \times 1. \times 8. \times G_H$ 5. $M_x = .46875 P_v$

6. $f_a = \frac{P_H}{2.13}$ 7. $f_{bx} = \frac{M_x \times 12}{2.29}$

8. $f_{by} = [22^2 - f_a^2 - f_{bx}^2]^{1/2}$ 9. $M_y = \frac{f_{by} \times 12}{12}$

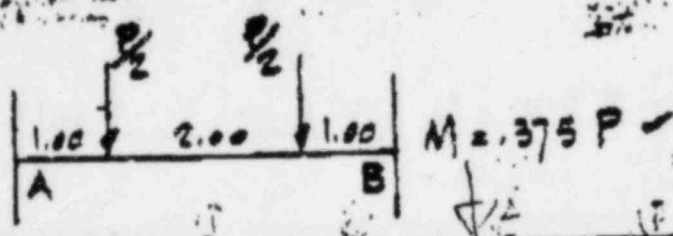
10. $P_L = \frac{M_y}{.46875}$ 11. $L_{MAX} = \frac{P_L}{.035 \times G_H}$

Date 11/4/78
 Calc By. E.H.C. IN
 Chk'd/Approved By. J.H.S.
 Subject SP-4 TYPE SUPPORT

Gibbs E.H.M. Inc.
 ENGINEERS, DESIGNERS, CONSTRUCTORS
 NEW YORK

Project Code 565-101C
 Sheet No. 3/93
 G & M Inc. No. 2323
 S-9903

CASE 2:



| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|-------|-------|--------------|--------------|-------|-------------|----------------|----------------|--------------|--------------|----------------|
| G_v | G_H | P_v (KIPS) | P_T (KIPS) | M_x | f_a (KSI) | f_{bx} (KSI) | f_{by} (KSI) | M_y (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 |
| 3.01 | 2.53 | 1.5736 | 1.4168 | .5901 | .6652 | 3.0922 | 21.7714 | .6223 | 1.6595 | 9.37 |
| 2.95 | 2.83 | 1.652 | 1.5648 | .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 |

- G_v
- G_H
- $P_v = .035 \times 2. \times B. \times G_v$
- $P_T = .035 \times 2. \times B. \times G_H$
- $M_x = .375 P_v$
- $f_a = \frac{P_T}{2.13}$
- $f_{bx} = \frac{M_x \times 12}{2.29}$
- $f_{by} = [22^2 - f_a^2 - f_{bx}^2]^{1/2}$
- $M_y = \frac{f_{by} \times .343}{12}$
- $P_L = \frac{M_y}{.375}$
- $L_{MAX} = \frac{P_L}{2. \times .035 \times G_H}$

Date 11/4/78

Calc By ENGIN

Checked By

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

Project Code 645-7010

Sheet No. 44

Job No. 2323

SP. 3 TYPE SUPPORT

MEMBER AE OR BD :

CASE 2 CONSIDERED ONLY

$$P = \frac{P_v}{2} \times \frac{6}{8} = \frac{1.652}{2} \times \frac{6}{8} = .6195 \text{ K} \quad (\text{FROM TABLE MAX VALUE})$$

$$P_A = \frac{P_L}{2} = \frac{1.6576}{2} = .8288 \text{ K}$$

$$f_a = \frac{.8288}{2.13} = .389 \text{ KSI}$$

$$M_x = .6195 \times 6 = 3.717 \text{ K}$$

$$M_y = .6195 \times 6 = 3.717 \text{ K}$$

$$M_x = \left[\frac{3.717^2}{2} + \frac{3.717^2}{2} \right]^{1/2} = 3.717 \text{ K}$$

$$f_b = \frac{3.717 \times 12}{2.29} = 19.48 \text{ KSI}$$

$$f = \left[.389^2 + 19.48^2 \right]^{1/2} = 19.75 \text{ KSI} < 22 \text{ OK}$$

BRACE :

FROM TABLE max $P_f = 1.792 \text{ K}$

$$\frac{KL}{r} = \frac{\sqrt{2} \times 6 \times 12}{.587} = 173.5$$

$$F_a = 6.77 \text{ KSI}$$

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

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

$$F_a = 7.96$$

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

Date 11/8/78
 Calc by ENG J...
 Check by V/S...

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

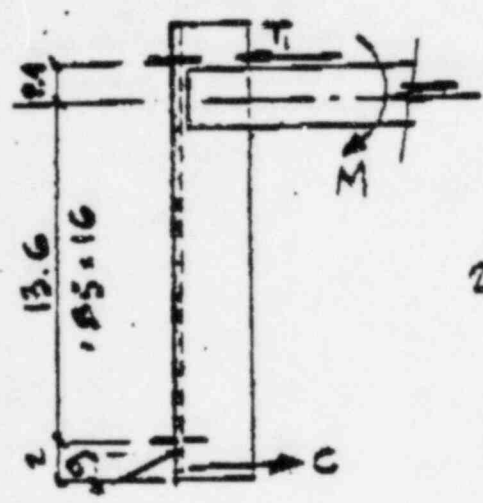
Project No. 64-101C
 Sheet No. 3/95
 Date of Issue 2.22.79
 Scale 1/4" = 1'-0"

SP-4 TYPE SUPPORT

BOLTS

BEAM CONNECTION

$M = 3.717$ (3.769 K OK FOR FOLLOWING CALCULATIONS)
 $M = 3.769$ K (SEE PREVIOUS SHEET)



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

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

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

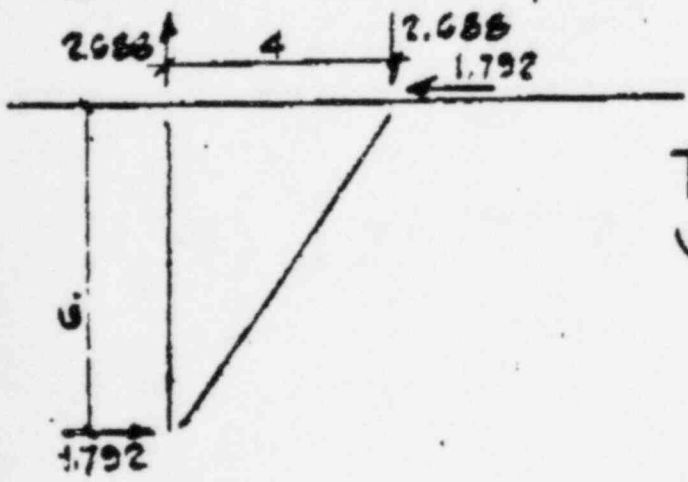
$a = .3008$ $T_1 = 2.53$ K

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

$T_3 = \frac{2.688 \times 13.6}{16} = 2.28$ (SEE BELOW) $T = [2.53^2 + 1.41^2 + 2.28^2]^{1/2} = 3.69$

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

BRACE CONNECTION



$T = 2.69$ K
 $V = 1.79$ K

LOW STRESSES

TEXAS UTILITIES GENERATING COMPANY

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

Rec'd 9/26/84
PROJECT FILE
Distribution

September 25, 1984

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

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

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

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. OR |
| CROSS REF. FILE | 2.1 Mc. OR 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.

TEXAS UTILITIES SERVICES INC.

OFFICE MEMORANDUM

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

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

L.M. Poppjewell

L.M. Poppjewell
CPPE Engineering Manager

PROJECT FILE

NOTED OCT 01 1984 H.WILLIAMS

TEXAS UTILITIES GENERATING COMPANY

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

September 28, 1984

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

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

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

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: | 2-11 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 A₁, B₁ and C₁ 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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New York, New York 10001
212 760- 4438
Telex:
Domestic: 127636/968694
International: 428813/234475
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

Gibbs & Hill, Inc.

GTN-

-2-

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

RM PTH
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

Sibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS: RESPONSE TO CYGNA'S PHASE II REVIEW
 Calculation Number SCS-101C Set 1 Sheet No. 147

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|-----------|---------|--------|------|--------|------|--------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | L. PALMER | 9-7-84 | | | | | | |
| Checker | | | NV | 9-17-84 | | | | | | |

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 B
- (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

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. 148

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|-----------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | ccch | 9-7-84 | | | | | | |
| Checker | | | L. Palmer | 9-25-84 | | | | | | |

Question 2.1.1 (cont.)

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 sk 162 & 163 R4.

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|-----------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | L. PALMER | 9-7-84 | | | | | | |
| Checker | | | 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:

C4 x 7.25 BEAM

$$g = 1"$$

$$d/2 = 2"$$

$$x = .459"$$

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

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

$$\text{Reduced } S_{x-x} = 1.948 \text{ in}^3 \left\{ \begin{array}{l} \text{Ref. 1} \\ \text{SH. 37} \\ \text{R. 2} \end{array} \right.$$

$$\text{Reduced } S_{y-y} = 0.297 \text{ in}^3$$

$$\text{Reduced Area} = 2.003 \text{ in}^2$$

P_h = transverse load from cable tray clamp

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

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

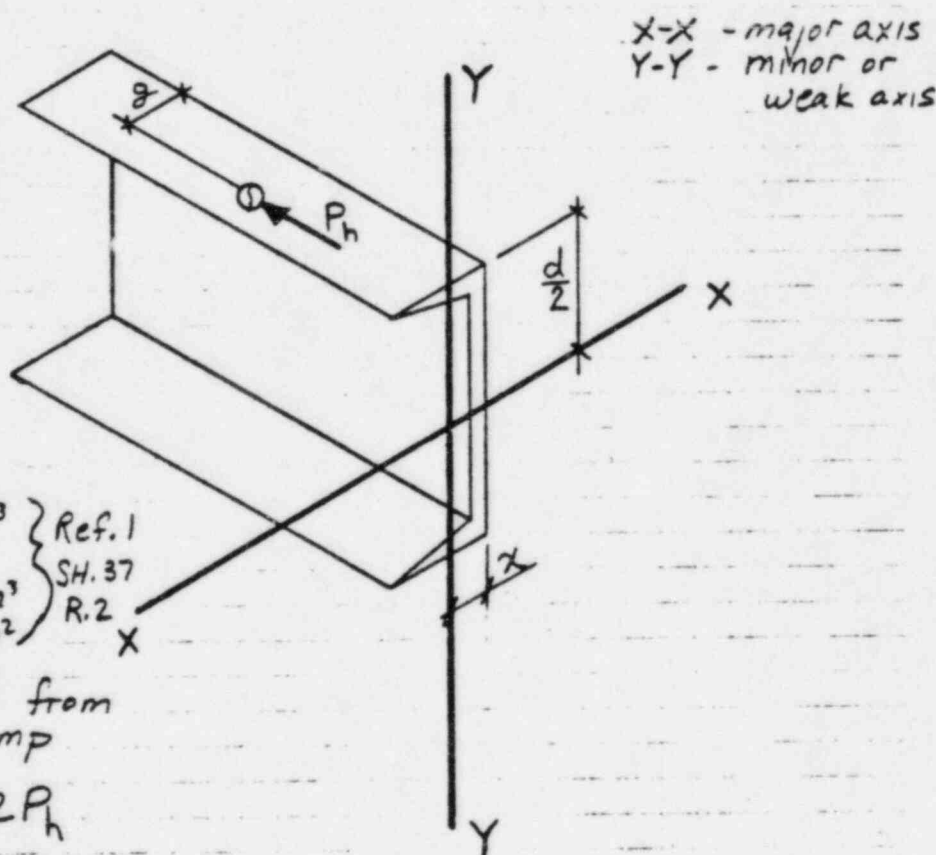
$$P_h = \frac{3.33^k}{4} = 0.832^k/\text{bolt} \quad (4 \text{ cable tray clamp bolts})$$

[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

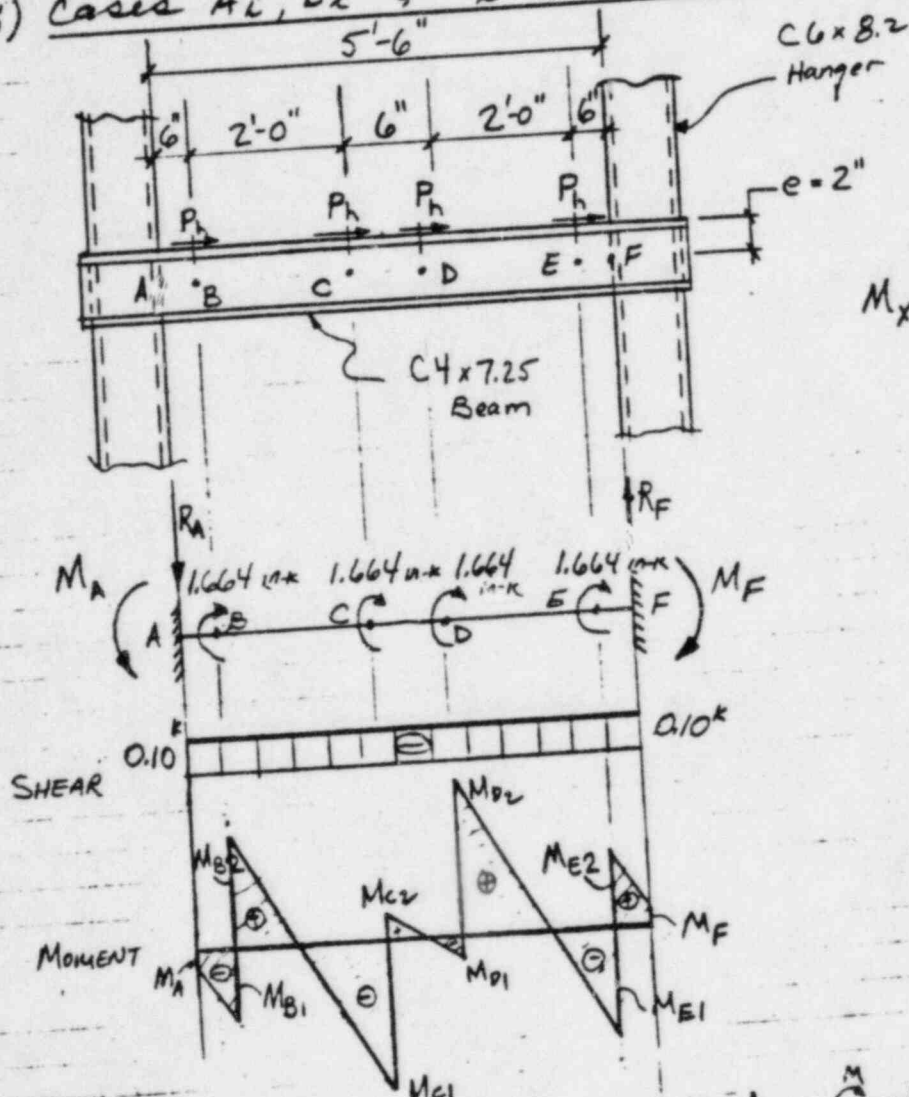
F-166, 7-82



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

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|-------------|---------|--------|------|--------|------|--------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | L. PALMISTO | 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)



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

SEE REFER. 5 Page 103

$$M_A = \frac{1.664(60)}{66} \left(1 - \frac{3(6)}{66}\right) + \frac{1.664(36)}{66} \left(1 - \frac{3(30)}{66}\right) + \frac{1.664(30)}{66} \left(1 - \frac{3(36)}{66}\right) + \frac{1.664(6)}{66} \left(1 - \frac{3(60)}{66}\right) = .0275 \text{ in-k}$$

$$M_F = -M_A = -.0275 \text{ in-k}$$

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

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. 151

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|-----------|---------|--------|------|--------|------|--------|------|
| Checking Method 3 | | | | | | | | | | |
| Preparer | | | L. PALMER | 9-7-84 | | | | | | |
| Checker | | | NV | 9-17-84 | | | | | | |

Question 2.1.1 (Cont)

$$R_A = V = -\frac{6(1.664)(6)(60)}{66^3} - \frac{6(1.664)(30)(36)}{66^3} - \frac{6(1.664)(36)(30)}{66^3} - \frac{6(1.664)(60)(6)}{66^3} = -0.10$$

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

$$M_{B1} = -0.0275 - 6(.10) = -0.6275 \text{ in-k}$$

$$M_{B2} = -0.6275 + 1.664 = 1.036 \text{ in-k}$$

$$M_{C1} = 1.036 - 24(.10) = -1.364 \text{ in-k}$$

$$M_{C2} = -1.364 + 1.664 = 0.300 \text{ in-k}$$

$$M_{D1} = 0.300 - 6(.10) = -0.300 \text{ in-k}$$

$$M_{D2} = -0.300 + 1.664 = 1.364 \text{ in-k}$$

$$M_{E1} = 1.364 - 24(.10) = -1.036 \text{ in-k}$$

$$M_{E2} = -1.036 + 1.664 = 0.6275 \text{ in-k}$$

$$M_F = 0.6275 - 6(.10) = 0.0275 \text{ in-k checks}$$

Check additional stresses @ Beam

@ point A (CRITICAL POINT):

$$\Delta f_{bx_A}^t = \frac{0.0275}{2.29} = 0.012 \text{ ksi negligible}$$

$$\Delta f_{bx_A}^t / F_{bx} = \frac{0.012}{22} = 0.05\%$$

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 CYENA PHASE 4 REVIEW

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

| Revision | Original Issue | Date | Rev. by | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|-------------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 9-21-84 | | | | | | |
| Checker | | | L. PALMIERI | 9-25-84 | | | | | | |

Question 2.1.1 (CONT)

@ point B : (Bolt hole location)

$$\Delta f_{bgB}^t = \frac{1.036}{1.948} = 0.532 \text{ ksi}$$

4h. 149 R4

$$\text{or } \frac{\Delta f_{bgB}^t}{F_{bx}} = \frac{0.532}{22} = 2.42\%$$

additional stresses @ hanger : C6x8.2

$$\Delta P_a = 0.1 \text{ K}, \Delta f_a^t = \frac{0.1}{2.4} = 0.042 \text{ ksi negligible}$$

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

$$= 0.0275 + 0.3 = 0.328 \text{ ''K}$$

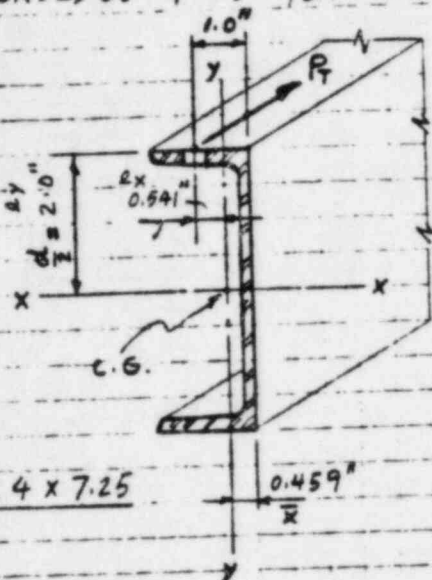
$$\Delta f_{bx hgr}^t = \frac{0.328}{4.38} = 0.075 \text{ ksi negligible}$$

$$\Delta f_{bx hgr}^t / F_{bx} = \frac{0.075}{22} = 0.34\%$$

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|----------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Drawing Method | | | | | | | | | | |
| Preparer | | | MC | 9-12-84 | | | | | | |
| Checker | | | SCS | 9-25-84 | | | | | | |

QUESTION 2.1.1 (CONT'D)

ii) CASES D₁ & D₂ W/BR (L = 1 TO 4)



TRANSVERSE SEISMIC (ECCENTRICITY)

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

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

REF. SCS-101C SET 3
 SH. 239, R. 9

FIXED END MOMENT:

REF. "ANALYSIS OF FRAMED STRUCTURES"

BY GERE & WEAVER
 © 1965, P. 433



$$M_{xA} = \frac{-0.6248}{8.0^2} \left[6.25(2 \times 1.75 - 6.25) + 4.25(2 \times 3.75 - 4.25) + 3.75(2 \times 4.25 - 3.75) + 1.75(2 \times 6.25 - 1.75) \right]$$

$$= -0.3245^{k-ft}$$

$$M_{xB} = M_{xA} = -0.3245^{k-ft}$$

Gibbs & Hill, Inc. Job No. 2323

Client TUGCO

Subject CABLE TRAY SUPPORTS — RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 1

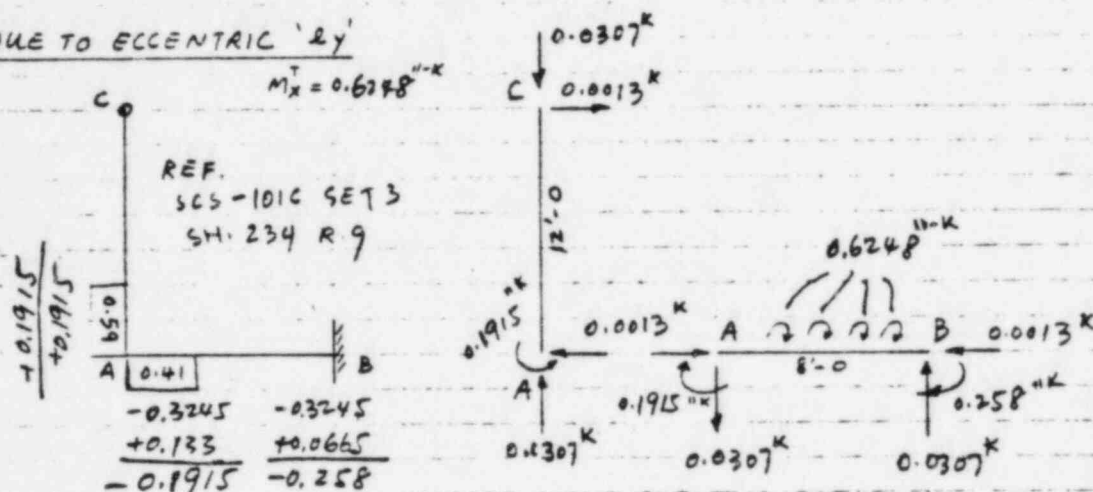
Sheet No. 154

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | W.C. | 9-12-84 | | | | | | |
| Checker | | | SCS | 9-25-84 | | | | | | |

QUESTION 2.1.1 (CONT'D)

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

DUE TO ECCENTRIC '2y'



BEAM @ PT. B, $\Delta f_{bx B}^T = \frac{0.258}{2.29} = 0.1127 \text{ KSI}$

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

HANGER

$$\Delta f_{bx A}^T = \frac{0.1915}{4.38} = 0.044 \text{ KSI}$$

$$\Delta f_a^T = \frac{0.0307}{2.4} = 0.0128 \text{ KSI}$$

NEGLIGIBLE

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

F-166, 7-82

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

Subject CABLE TRAY SUPPITS - 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 # | | | | | | | | | | |
| Preparer | | | SCS | 9.21.84 | | | | | | |
| Checker | | | L. PALMER | 9.25.84 | | | | | | |

Question 2.1.1 (cont)

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

TRANSVERSE SEISMIC:

Ref. to SCS-101C Set 3 Sh 236 to 239 R9

$$f_{ext} = \frac{1}{\sqrt{\frac{1}{f_1^2} + \frac{1}{f_2^2}}} = \frac{1}{\sqrt{\frac{1}{77.3^2} + \frac{1}{18.97^2}}} = 18.42 \text{ Hz} \Rightarrow g_h = 1.1415$$

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

Ref. DMI-11C Set 3 Sh 19 R0

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

USE $g_h = 1.0$

$$P^t = 0.035 \times 2.5 \times 8.5 \times 1 = 0.744 \text{ K}$$

$$\Delta M_x^t = 0.744 \times 3' = 2.232 \text{ "K}$$

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

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

F-166, 7-82

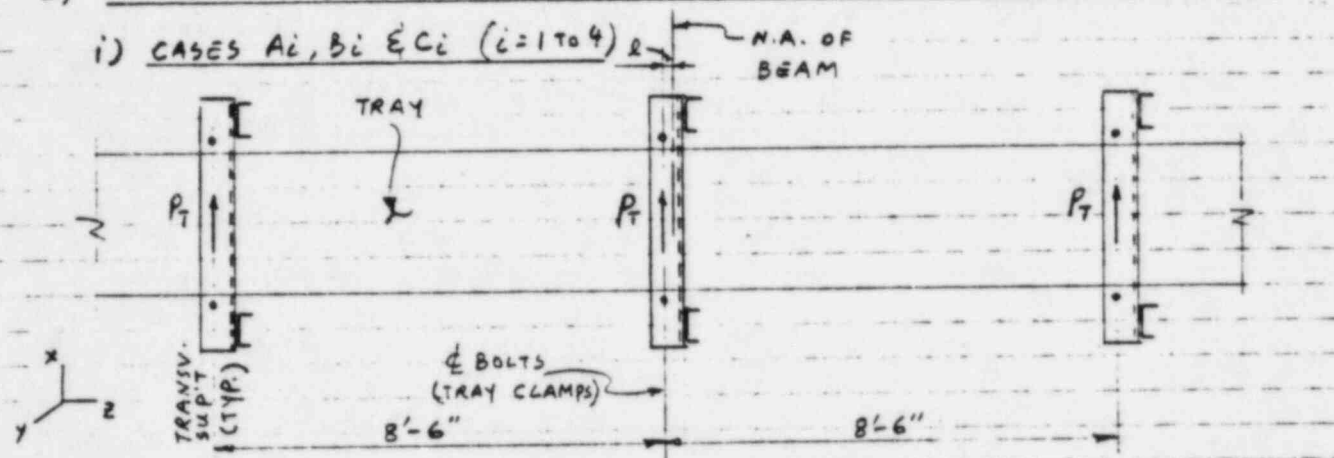
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-101C SET 1 Sheet No. 156

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| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | W.C. | 9-14-84 | | | | | | |
| Checker | | | SCS | 9-25-84 | | | | | | |

QUES. 2.1.1 (CONT'D)

2) MINOR AXIS BENDING DUE TO ECCENTRICITY OF TRANSVERSE LOAD

i) CASES A1, B1 & C1 (i=1 to 4)



BENDING MOMENT ABOUT MINOR AXIS DUE TO ECCENTRICITY 'e', $M_y = P_T \times e$

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 $I_{yy} = 4.13 \text{ in}^4$
 SEE SCS-101C SET 5
 SH. 30 R. 3)

BEAM C4 x 7.25

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

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

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| Preparer | | | See SCS-10/C | 9-21-84 | | | | | | |
| Checker | | | L. PALMER | 9-25-84 | | | | | | |

Question 2.1.1 (cont)

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



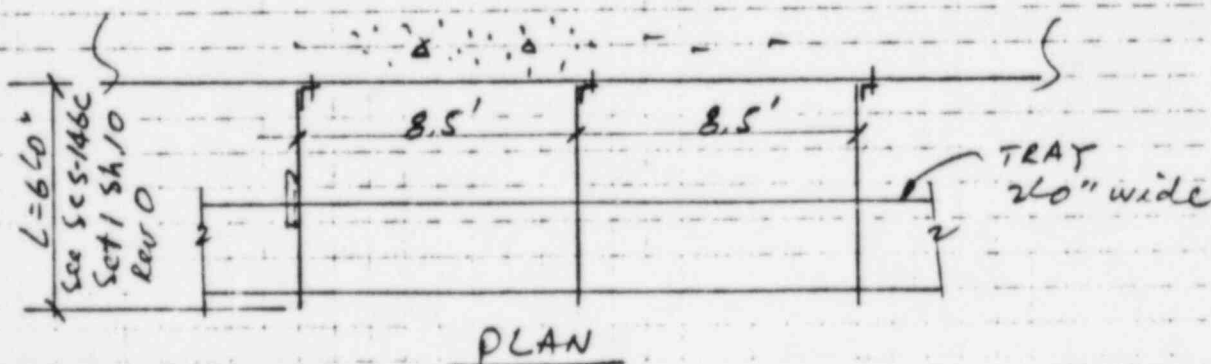
STIFFNESS:

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

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

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

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



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

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

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

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| Preparer | | | SCS | 8-21-84 | | | | | | |
| Checker | | | L. PALMISTO | 9-25-84 | | | | | | |

Question 2.1.1 (cont)

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

$$K_{\text{beam}} = \frac{0.693}{6.0} = 0.1155$$

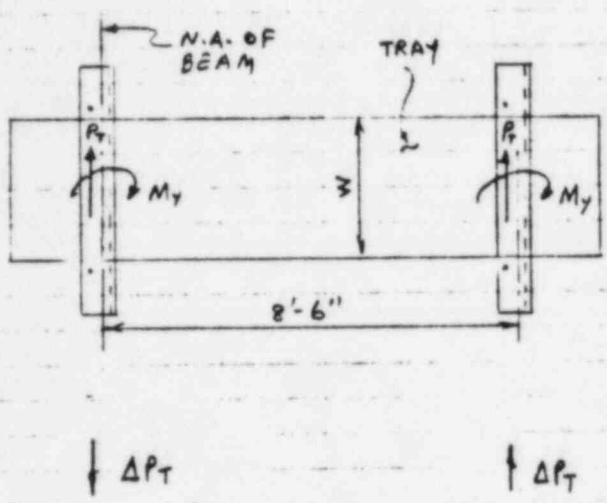
$$\frac{K_{\text{tray}}}{K_{\text{beam}}} = \frac{0.486}{0.1155} = 4.21$$

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:

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| Preparer | | | MC | 9-14-84 | | | | | | |
| Checker | | | SCS | 9-25-84 | | | | | | |

QUES. 2.1.1 (CONT'D)



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

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

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

$e = \text{ECCENTRICITY, IN.}$

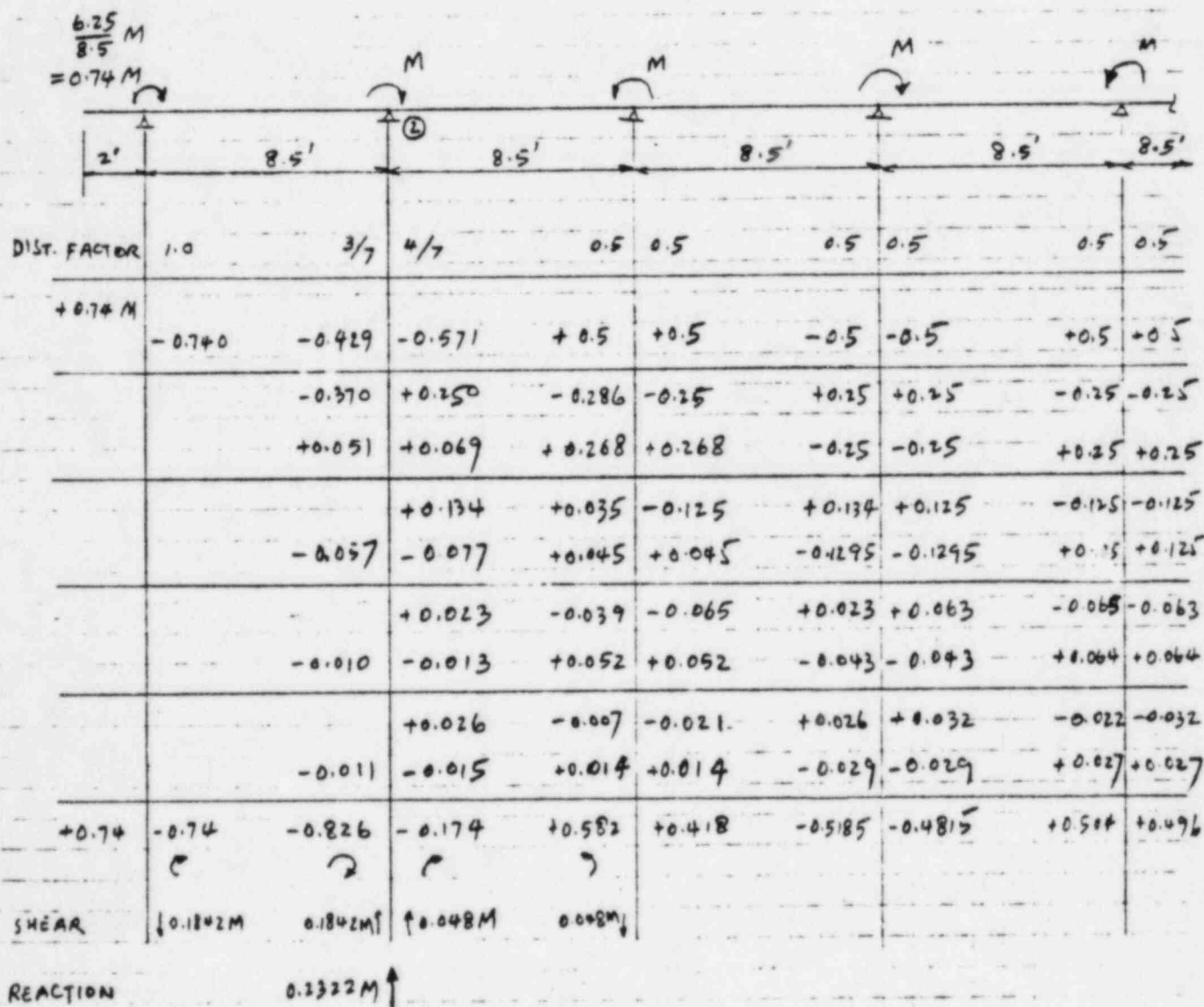
ADDITIONAL TRANSV. FORCE, ΔP_T

Gibbs & Hill, Inc. Job No. 2223 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
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| Preparer | | | MC | 9-14-84 | | | | | | |
| Checker | | | SCS | 9-25-84 | | | | | | |

QUES. 2.1.1 (CONT'D)

$$M = 8.5K \times \frac{2''}{12} = 0.7083 K \cdot L / \#$$



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| Preparer | | | WC | 9.14.84 | | | | | | |
| Checker | | | scs | 9.25.84 | | | | | | |

QUES. 2.1.1 (CONT'D)

Critical Location

SUP'T @ ②: $P_T = 8.5 K$

$$\frac{\Delta P_T}{P_T} = \frac{0.2322 \times 0.7083 K\Omega}{8.5 K} = 0.01932 \leftarrow \text{GOVERNS}$$

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

$$L = 1.0 - 0.459 = 0.541''$$

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

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/B.R. ($i=1$ to 4), SP-7 & SP-7 W/B.R SINCE THE STRESSES DUE TO VERTICAL LOADS are the governing stresses in the design.

TRAY @ ②:

$$\Delta M_y^T = 0.826 M = 0.826 \times (0.7083 K\Omega) = 0.5851 K\Omega^{1\#}$$

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

$$\frac{\Delta M_y^T}{M_y^T} = \frac{0.5851 K\Omega}{7.225 K} = 0.0812$$

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

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|-------------------|----------------|------|-----------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Prepare | | | SCCH | 9-21-84 | | | | | | |
| Checker | | | L. PALMER | 9-25-84 | | | | | | |

Question 2.1.1 (cont)

SUMMARY & CONCLUSION:EFFECT OF MAJOR AXIS BENDINGDUE TO ECCENTRICITY OF TRANSVERSE LOADS

$$F_{bx} = 22. \text{ ksi}$$

| SUPPORT CASE $i = 1 \text{ to } 4$ | HANGER | | BEAM | | | | REMARKS |
|---------------------------------------|--------------------------------|------------------------|--------------------------------|------------------------|--------------------------------|------------------------|---|
| | Δf_{bx} ^{ksi} | $\Delta f_{bx}/F_{bx}$ | @ END | | @ BOLT HOLE | | |
| | | | 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

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Gibbs & Hill Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPITS - RESPONSE TO CYGNA PHASE 4 REVIEW

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| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCC | 9.21.88 | | | | | | |
| Checker | | | J. 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 | $\Delta P_T / P_T$ | | | REMARKS |
|----------------------------|--------------------|-------|---------|--|
| | HANGER | BEAM | TRAY | |
| 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

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| Preparer | | | Sech | 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

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

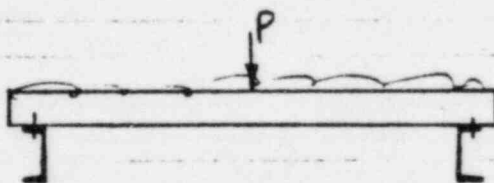
Calculation Number SCS-101C Set 1 Sheet No. 165

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| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | Sec | 9-19-84 | | | | | | |
| Checker | | | W.C. | 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

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| Preparer | | | SCS | 5/19/82 | | | | | | |
| Checker | | | ML | 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.

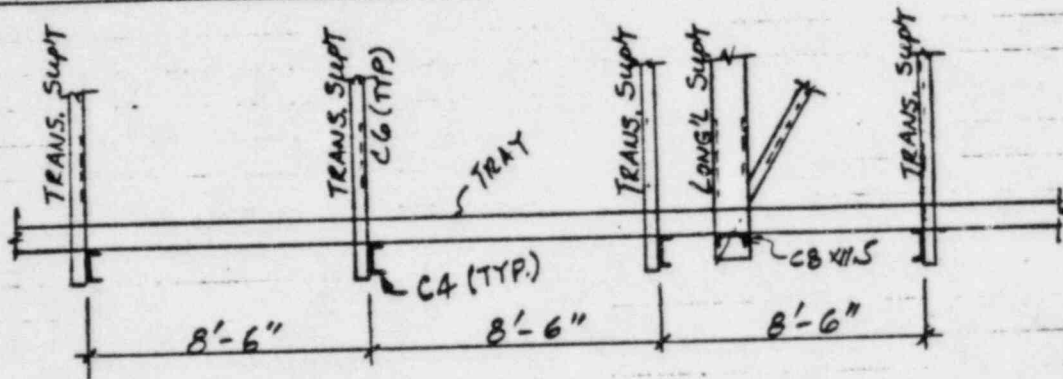
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPITS - RESPONSE TO CYGNA PHASE 4 REVIEW
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| Preparer | | | SCS | 9-13-84 | | | | | | |
| Checker | | | ML | 9-26-84 | | | | | | |

Question 2.1.2 (cont)

1) TRANSVERSE SUPPORTS:

STIFFNESS OF MEMBERS:



ELEVATION

CABLE TRAY: 2'-0" WIDE, $I_{xx} = 2.46 \text{ IN}^4$
 (REF. SCS-101C, SET 5, SH 30 & 3)

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

BEAM C4x7.25 : $J = 0.082 \text{ IN}^4$ (Ref. 8 torsional constant)
 $a = 6.25"$, $L/a = \frac{3 \times 12}{6.25} = 5.76$

Case 6: (conservative)

$$2/L = 0.5, \phi \left(\frac{GJ}{M} \cdot \frac{1}{a} \right) \approx 0.544$$

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

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

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

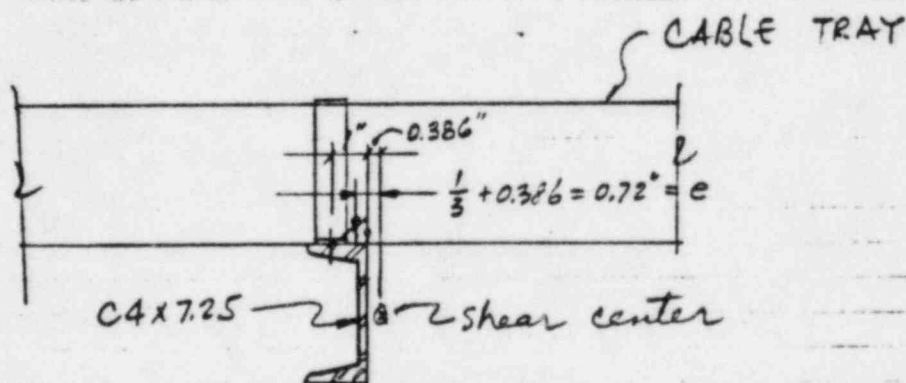
F-166, 7-82

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| Preparer | | | SCC | 9/19/94 | | | | | | |
| Checker | | | WLC | 9-26-94 | | | | | | |

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

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

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

$$\Delta M_v = 1.67 (\Delta M_{D.L.}) = 0.715 \text{ \"K}$$

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

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| Preparer | | | Scch | 9-15-84 | | | | | | |
| Checker | | | MC | 9-26-84 | | | | | | |

Question 2.1.2 (cont)

$$(6.25/8.5)M$$

$$= 0.74M$$

| | | | | | | |
|-------|----------|----------|---------|--------|--------|--------|
| | 2' 0" | 8.5' | 8.5' | 8.5' | 8.5' | |
| | 1.0 | 3/7 | 4/7 | 0.5 | 0.5 | 0.5 |
| | | | | | | |
| +0.74 | -0.74 | -0.429 | -0.571 | +0.5 | +0.5 | -0.5 |
| | | -0.37 | +0.25 | -0.286 | -0.25 | +0.25 |
| | | +0.051 | +0.069 | +0.268 | +0.268 | -0.25 |
| | | | +0.134 | +0.035 | -0.125 | +0.134 |
| | | | -0.057 | -0.077 | +0.045 | +0.045 |
| | | | | +0.023 | -0.039 | -0.065 |
| | | | | -0.010 | -0.013 | +0.052 |
| | | | | | +0.026 | -0.007 |
| | | | | | -0.011 | -0.015 |
| | | | | | | +0.014 |
| | | | | | | -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 | +0.1842M | +0.048M | 0.048M | | |

REACTION

$$0.2322M, M = [1K]$$

$$\text{Sup't @ B: } \Delta P_{oL} = 0.2322 \times \Delta M_{oL} = 0.2322 \times 0.428/12 = 0.00828K$$

$$\frac{\Delta P_{oL}}{P_{oL}} = \frac{0.00828}{0.595} = 1.39\%$$

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

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

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

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| Preparer | | | 6/26/82 | 9/10/82 | | | | | | |
| Checker | | | VJC | 7-16-82 | | | | | | |

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/BK 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/BK 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

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

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

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| Preparer | | | SECH | 9-20-84 | | | | | | |
| Checker | | | MC | 9-26-84 | | | | | | |

Question 2.1.2 (cont)

Check TRAY

Tray @ B:

$$\Delta M_{x o.l.} = 0.826 M = 0.826 (0.428) = 0.354 \text{ "K}$$

$$M_{x o.l.} = \frac{1}{10} (0.035 \times 2) (8.5)^2 \times 1.2 = 6.07 \text{ "K}$$

$$\frac{\Delta M_{x o.l.}}{M_{x o.l.}} = \frac{0.354}{6.07} = 5.83\%$$

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

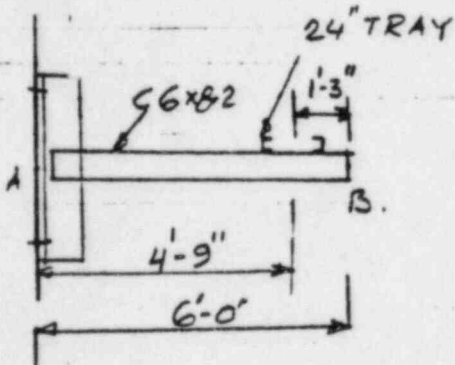
Checking Method #

1. Line-by-line checking
2. Alternative Calculation Results compared
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| Checking Method # | | | 1 | | | | | | | |
| 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

$$P_{o.l. \text{ tray}} = 2 \times 35 \times 8.5 = 595 \text{ \#}$$

$$P_{o.l. \text{ beam}} = 8.2 \times 6 = 49.2 \text{ \#}$$

$$\Sigma P_{o.l.} = 644.2 \text{ \#}$$

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

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

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

$$f_{\text{support}} = \frac{1}{2\pi} \sqrt{\frac{4.6 \times 386.4}{644.2}} = 8.36 \text{ Hz}$$

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

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

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

* Ref. DMI-11C Set 3 SH 18 RO

Interior span:

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

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

$$\therefore g_v = 1.6$$

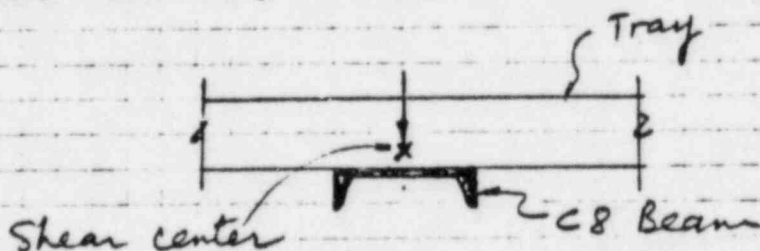
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-10/C Set 1 Sheet No. 173

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 9.20.90 | | | | | | |
| Checker | | | MAC | 9.26.90 | | | | | | |

Question 2.1.2 (cont)

2) Longitudinal cable tray supports:

Longitudinal cable tray support cases L-Ai, L-Bi & L-Ci (i.e. 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

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPITS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-101C Set 1 Sheet No. 174

| Revision | Original Date | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|----------------------|------------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | Scs | 8-21-84 | | | | | | |
| 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%* | SUPITS 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 SUPPTS - 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 | | | SCL | 5-24-84 | | | | | | |
| Checker | | | L. PALMISTO | 9-25-84 | | | | | | |

Question - 2.1.3: (CYGNA LTR #4056.031 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 #4056.031 dated 2/31/84 from CYGNA to Mr. J. B. George of TUGCO, item 2.1.3 attachment A.
- 2) G & H drawing 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 SUPPTS - RESPONSE TO CYENA 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 | | | Sccl | 9-26-84 | | | | | | |
| Checker | | | L. PALMER | 9-26-84 | | | | | | |

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-A_i, L-B_i, L-C_i (i=1 to 4)

Group 2; D_i W/B_R (i=1 to 4)

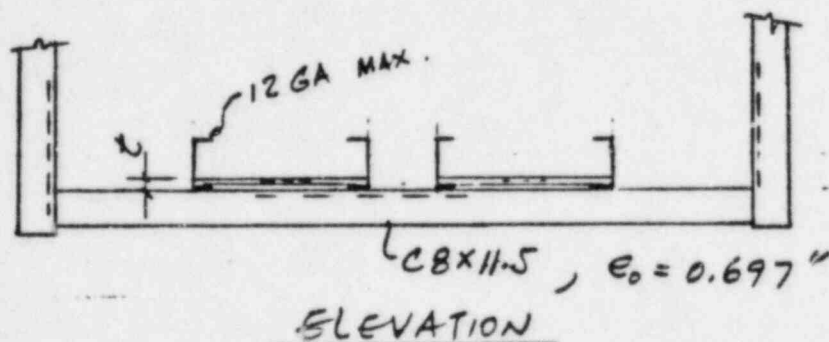
Group 3; SP-7 W/B_R

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

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|-------------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCC | 9/11/84 | | | | | | |
| Checker | | | L. PALMISTO | 9-25-84 | | | | | | |

Question 2.1.3 (cont)

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



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

$$t_{max} = 0.1084 + \frac{13}{16} = 0.9209"$$

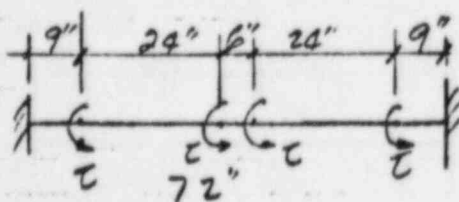
FOR TROF. TYPE: GF-24SL-12-CP

$$t_{max} = 0.1084 + \frac{3}{8} + 0.0516 = 0.535"$$

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

$$ECCENTRICITY, e = 0.9209 - 0.697 = 0.224" \text{ (GOVERN)}$$

$$\text{or } = 0.697 - 0.535 = 0.162"$$



$$T = \frac{7.48}{2} \times 0.224 = 0.838"K$$

Ref. SCS-101C Set 2 Sh 124 R5

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

Subject CABLE TRAY SUPPLTS - 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 9 | | | | | | | | | | |
| Preparer | | | SCS | 9/11/84 | | | | | | |
| Checker | | | L. RUMIE | 9-25-84 | | | | | | |

Section - 2.1.3 (cont)

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 $z/L = 0.46$

$\phi'' \left(\frac{GJ}{M} \cdot a \right) = (0.0306 + 0.393) \times 2 = 0.8272$ ^{conservative}

$\phi'' = \frac{0.8272 M}{GJ a}$

$= \frac{0.8272 \times 0.838}{11.2 \times 10^3 \times 0.13 \times 18.0} = 0.026 \times 10^{-3}$

$T_{90} = E W_{90} \phi''$

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

$= 3.85 \text{ ksi}$

Since g_L is reduced from 2.67 to

1.75 (See SCS-101C Set 2, Sh 132, RS) &

BEAM @ MIDSPAN IS CRITICAL (Sh 126 RS)

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

$= 0.738 \ll 1.0$

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.

F-166, 7-82

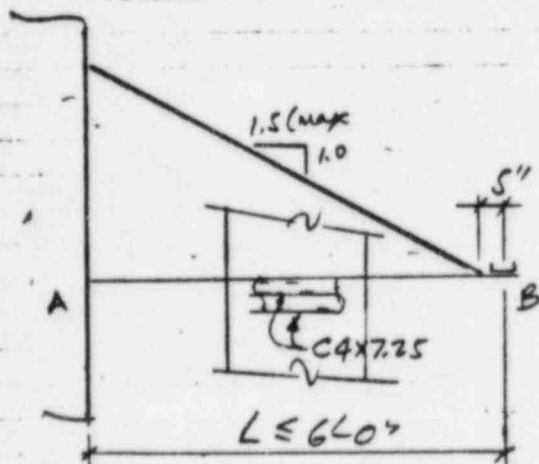
| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|--------|---------|--------|------|--------|------|--------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | SCC | 9/11/84 | | | | | | |
| Checker | | | NV | 9/19/84 | | | | | | |

Question 2.1.3 (cont)

Group 2:

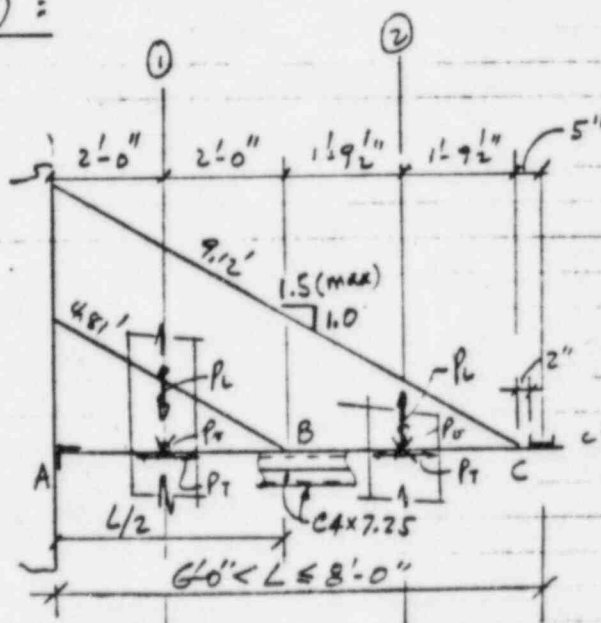
CASES D_i w/BR ($i=1$ to 4):

Ref. BK SCS-215C SET 4 SH 62 RD



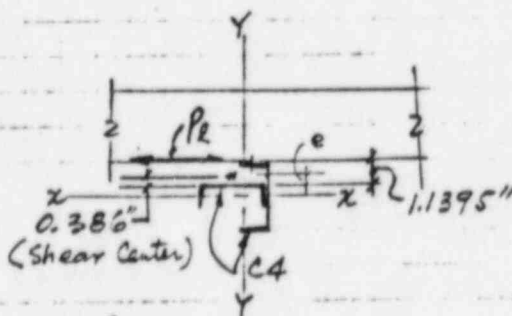
PLAN

CASE 2



PLAN

CASE 1



SECTION A-A

The inflection point:

$$e = (1.1395 - 0.296 - \frac{1}{2} \times \frac{3}{16}) / 2$$

fillet weld

$$= 0.3905 \sim 0.386 \text{''}$$

shear center of horiz channel (m).

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 (m).

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 TUG CO

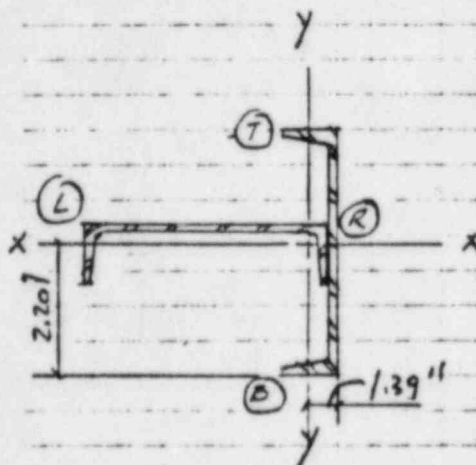
Subject CABLE TRAY SUPP.T. - RESPONSE TO CYGNA PHASE II REVIEW

Calculation Number SCS-101C SET 3

Sheet No. 249

| Revision | Original Issue | Date | Rev. | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | NV | 9.18.50 | | | | | | |
| Checker | | | SCS | 9.26.54 | | | | | | |

Question 2.1.3 (cont)

PROPERTY OF COMBINED SECTION:

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

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

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

$$I_y = 4.59 + 0.433 + 2.13 \times 0.921^2 + 2.13 \times 0.931^2 = 8.715 \text{ IN}^4$$

$$S_x(T) = \frac{5.195}{(4.0 - 2.201)} = 2.888 \text{ IN}^3$$

$$S_x(B) = \frac{5.195}{2.201} = 2.36 \text{ IN}^3$$

$$S_y(L) = \frac{8.715}{(4.321 - 1.39)} = 2.973 \text{ IN}^3$$

$$S_y(R) = \frac{8.715}{1.39} = 6.27 \text{ IN}^3$$

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

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. 250

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | NV | 9.19.94 | | | | | | |
| Checker | | | SCS | 9.25.94 | | | | | | |

Question 2.1.3 (cont)

CASE 1:

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

$$L = 8'-0" \quad W/2-24" \text{ TRAYS} \quad g_A = 1.10$$

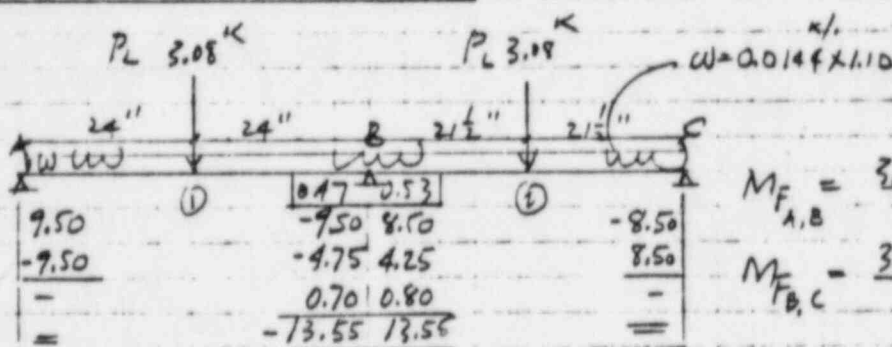
$$P_V^{DL} = 0.035 \times 2 \times 8.5 \times 1.10 = 0.595^K$$

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

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

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

MOM. DUE TO LONGIT. LOS. P_L



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

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

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

$$V_C = \frac{3.08 \times 21.5}{4} + \frac{1}{2} (0.0144 \times 1.1 \times 3.58 \times 43) - 13.55 = 1.123^K$$

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

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

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

F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323

Client TUGCO

Subject CABLE TRAY SUPP.T. - RESPONSE TO CYGNA PHASE II REVIEW

Calculation Number SCS-101C SET 3

Sheet No. 25/

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | NV | 9.19.84 | | | | | | |
| Checker | | | SCS | 9.25.84 | | | | | | |

Question 2.1.3 (cont.)

Q (1)-(1) (SEE PLAN) CRITICAL

LOCAL BENDING STRESSES DUE TO P_L

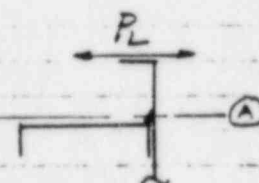
$$M_{(A)-(A)}^L = 3.08 \times 0.3905'' = 1.203''K$$

EFFECTIVE WIDTH OF SECTION

$$24'' + 3'' + 3'' = 30''$$

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

$$f_{b(A)-(A)}^L = \frac{1.203}{0.515} = 2.34 \text{ KSI.} < 27 \text{ KSI.}$$



CHECK BUILT-UP BEAM @ SECT. (1)-(1)

$$M_y^L = 29.4''K \text{ (MAX.)}$$

$$P_{AXIAL}^L = (1.123 + 3.87) \times 1.5 = 7.49''K$$

$$P_{AXIAL}^T = 0.051 + [(0.051 \times 1.67)^2 + (0.0542 + 1.248 + 0.00725 \times 1.1 \times 8)^2]^{1/2} = 1.42''K$$

REF. TO SET 3 SH. 240 R.9

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

$$M_x = 1.306''K \times 12 = 15.7''K$$

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 TUGLO

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

Calculation Number SCS-101C SET 3

Sheet No. 252

| Revision | Original | Date | Rev. 1 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | NV | 9.19.84 | | | | | | |
| Checker | | | SCS | 9.25.84 | | | | | | |

Question 2.1.3 (cont.) ;

$$f_{bx}^{DL} = \frac{9.39}{2.888} = 3.25 \text{ KSI.}$$

$$f_{bx}^V = \frac{15.7}{2.888} = 5.44 \text{ KSI.}$$

$$f_{by}^L = \frac{29.4}{2.973} = 9.89 \text{ KSI.}$$

$$f_a^T = \frac{1.42}{2 \times 2.13} = 0.333 \text{ KSI.}$$

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

$$\frac{P_a^L}{F_a} = \frac{1.758}{14.56} = 0.121 < 0.150$$

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

INTERACTION FOR SEISMIC

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

CONSERV. DUE TO ECCENTRICITY

SEE SCS-101C SET 1 SH 182 R.4

∴ BUILT UP BEAM 2-C4x7.25 (E) IS ADEQUATE
and has 21.8% margin.

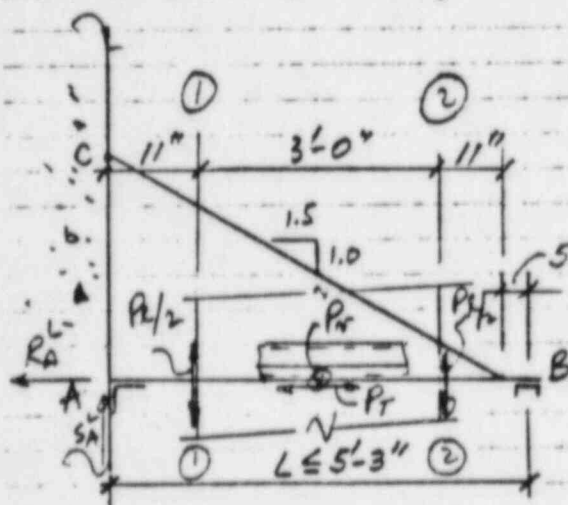
| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|--------|---------|--------|------|--------|------|--------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | See 6 | 9.25.94 | | | | | | |
| Checker | | | NV | 9.15.94 | | | | | | |

Question 2.1.3 (cont)

Case Di W/BR (i = 1 to 4) :

Case 2: Ref to SCS-215C SET 4 Sh 59 & 60 RO

$$g_L = 1.848$$



$$P_R = 0.035 \times 3 \times 40 \times 1.848 = 7.76^k$$

$$W_{AB} = 0.0145 \times 1.848 = 0.027^k$$

$$W_{BC} = 0.0072 \times 1.848 = 0.013^k$$

$$R_A^L = \left(\frac{7.76 \times 2.42}{4.83} + 0.027 \times 2.63 + 0.013 \times 4.5 \right) \times 1.5 = 6.03^k$$

$$S_A^L = \frac{7.76}{2} + 0.027 \times 2.63 = 3.95^k$$

PLANLOCAL BENDING STRESSES DUE TO P_L :

$$M_y^L = 7.76 \times 0.3905 = 3.03^{in-k}$$

$$b_{eff} = 36 + 3 \times 2 = 42^{\prime\prime}, \quad S_y = \frac{1}{6} (42) (0.321)^2 = 0.7213^{in^3}$$

$$f_{by}^L = \frac{3.03}{0.7213} = 4.2^{ksi}$$

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

Subject CABLE TRAY SUPPLIES - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 254

| Revision | Original | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | Scot | 5.25.84 | | | | | | |
| Checker | | | NV | 7.25.84 | | | | | | |

Question 2.1.3 (cont.)

CHECK BUILT-UP BEAM @ SECT ①-①

$$M_y^L = 3.95 \times 11 = 43.45 \text{ K} \cdot \text{ft}$$

$$f_{by}^L = \frac{43.45}{2.973} = 14.61 \text{ ksi}$$

$$f_o^L = \frac{6.03}{2 \times 2.13} = 1.42 \text{ ksi}$$

Ref to SH 250 Rev. 9;

$$f_o^L / f_a = 1.42 / 14.56 = 0.098 < 0.15$$

AISC 1.6-2

$$\left[\frac{3.25}{22} \right]_{D.L.} + \sqrt{\left(\frac{5.44}{22} \right)_V^2 + \left(\frac{0.333}{14.56} \right)_T^2 + \left(0.098 + \frac{14.61}{22} \right)_L^2} \times 1.015$$

$$= 0.963 < 1.0 \quad \text{O.K.}$$

Conservative, due to eccentricity
SEE SCS-101C Set 1
SH 182 & 4

BUILT-UP BEAM 2-C4x7.25 IS ADEQUATE
and has 3.7% 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

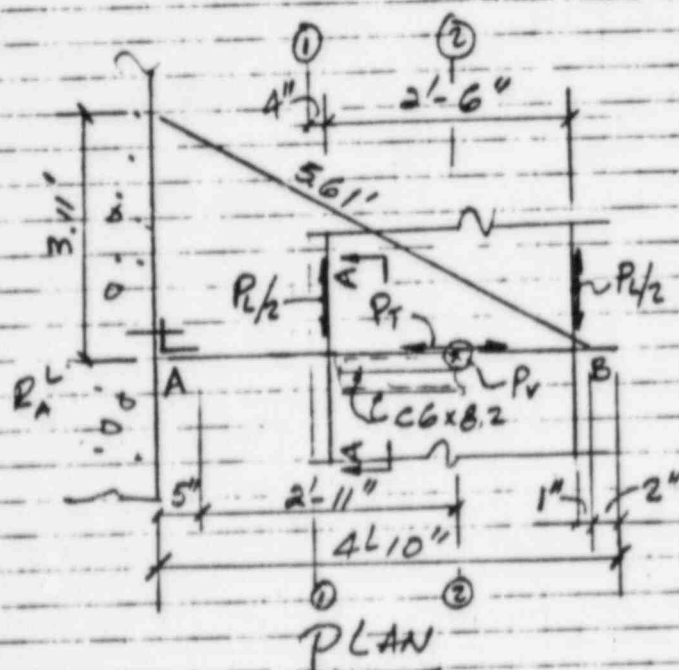
Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 255

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 2/9/04 | | | | | | |
| Checker | | | GPT | 3/25/04 | | | | | | |

Question 2.1.3 (CONT)

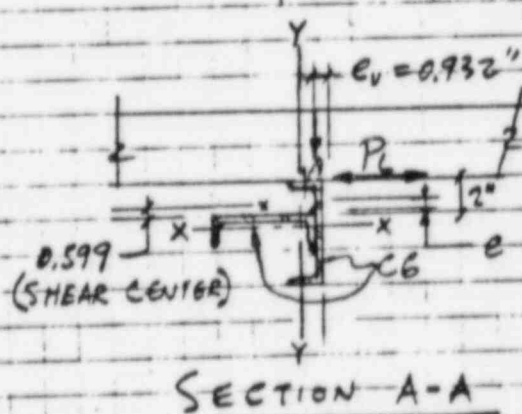
Group 3: SP-7 W/BR



2'-6" TRAY } Ref. SCS-146C
L = 4'-10" } SET 1 SH 29, 20

$$g_v = g_t = 2.67$$

$$g_L = 1.12 \text{ Ref SCS-215C Set 4 SH 49 \#50 R0}$$



ASSUMPTIONS:

- 1) TOP FLANGE OF VERT. CHANNEL (7) 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 $b_{eff} = (2'-6") + 7" = 3'-1"$

Checking Method #

Line-by-line checking
Alternative Calculation Results compared
Identical Calculation Results compared
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. 256

| Revision | Original Issue | Date | Rev. | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|----------|----------------|------|------|------|------|------|------|------|------|------|
| 1 | | | 1 | | | | | | | |
| 2 | | | 2 | | | | | | | |
| 3 | | | 3 | | | | | | | |
| 4 | | | 4 | | | | | | | |
| 5 | | | 5 | | | | | | | |
| 6 | | | 6 | | | | | | | |
| 7 | | | 7 | | | | | | | |
| 8 | | | 8 | | | | | | | |
| 9 | | | 9 | | | | | | | |
| 10 | | | 10 | | | | | | | |

Question 2.1.3 (cont)

THE INFLECTION POINT, e ,

$$e = (2'' - \frac{13''}{16} - \frac{1}{3} \times \frac{3''}{16}) / 2 = 0.5625''$$

$$e + \frac{1}{16}'' = 0.5625'' + \frac{1}{16}''$$

$$= 0.625'' \sim 0.599'' \text{ SHEAR CENTER OF THE HORIZ. CG (M)}$$

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 (M) 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

F-166, 7-82

Checking Method #

1. Line-by-line checking
 2. Alternating Calculation Results compared
 3. Computer Calculation Results compared
 4. Compare inputs and results of computer with corresponding inputs and results of similar codes

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 2/12/20 | | | | | | |
| Checker | | | GRT | 9/25/22 | | | | | | |

Question 2.1.3 (cont)

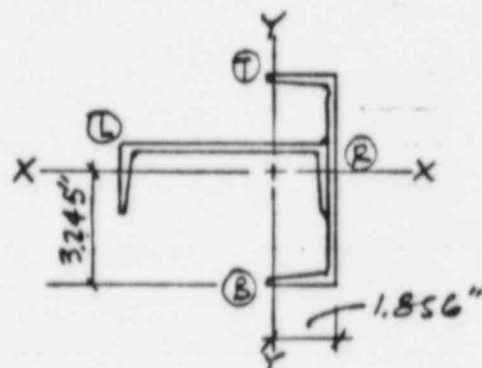
THEORETICALLY LINES UP WITH THE SHEAR CENTER OF THE HORIZ. CHANNEL. THE LONG'L TRAY LOAD P_L , INSTEAD, WILL CREATE EQUAL LOCAL BENDINGS AT THE TOP FILLET OF WEB OF THE VERT. CHANNEL AND AT THE TOP FILLET WELD.

PROPERTIES OF THE BUILT-UP SECTION:

2 - C6x8.2

$$\bar{X} = \frac{2.4(0.511 + 3.2)}{2 \times 2.4} = 1.856"$$

$$\bar{Y} = \frac{2.4[3 + (4 - 0.511)]}{2 \times 2.4} = 3.245"$$



$$I_x = 13.1 + 0.693 + 2.4 \times 0.245^2 + 2.4 \times (6 - 3.245 - 2.511)^2 = 14.08 \text{ in}^4$$

$$I_y = 13.1 + 0.693 + 2.4(1.856 - 0.511)^2 + 2.4(3.2 - 1.856)^2 = 22.47 \text{ in}^4$$

$$S_{x\text{①}} = \frac{14.08}{6 - 3.245} = 5.11 \text{ in}^3; \quad S_{x\text{②}} = \frac{14.09}{3.245} = 4.34 \text{ in}^3$$

$$S_{y\text{③}} = \frac{22.47}{1.856} = 12.11 \text{ in}^3; \quad S_{y\text{④}} = \frac{22.47}{6.2 - 1.856} = 5.17 \text{ in}^3$$

$$r_x = \sqrt{\frac{14.08}{2 \times 2.4}} = 1.713 \text{ in}; \quad r_y = \sqrt{\frac{22.47}{2 \times 2.4}} = 2.164 \text{ in.}$$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPLS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-10/C SET 3 Sheet No. 258

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method 2 | | | | | | | | | | |
| Preparer | | | SCC | 2/11/84 | | | | | | |
| 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)

$$M_y^L = 3.92 \times 0.5625 = 2.205''^k$$

$$S_y = \frac{1}{6} (37)(0.2)^2 = 0.247 \text{ in}^3$$

$$f_{by}^L = 2.205 / 0.247 = 8.93 \text{ ksi}$$

CHECK BUILT-UP BEAM @ SECTION ①-①: (OR
 @ INNER SIDERAIL OF TRAY)

$$P_v^{D.L.} \text{ BRACE} = 0.0072 \times 5.61 = 0.04^k$$

$$M_{xx}^{D.L.} = 0.744 \times 1.58 + \frac{1}{2} (0.0164) (3.01)^2 + 0.02 \times 2.92 = 1.31''^k$$

$$M_{xx}^V = 1.67 M_{xx}^{D.L.} = 2.19''^k$$

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

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. 259

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. 2 | Date | Rev. 3 | Date | Rev. 4 | Date |
|-------------------|----------------|------|--------|---------|--------|------|--------|------|--------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | SEB | 2/16/84 | | | | | | |
| Checker | | | SRF | 9/25/84 | | | | | | |

Question 2.1.3 (cont)

$$\Sigma P_T = 1.987 + (0.0164 \times 4.83 + 0.02) \times 2.67 = 2.25^k$$

$$R_A^L = \left[\frac{3.92}{2} (4.58 + 2.08) + (0.0164 \times 2.42 + 0.02 \times 4.67) \times 1.12 \right] / 3.11$$

$$= 4.25^k$$

$$M_{TY}^L = (3.92/2)(20)(31)/51 = 23.83^{in-k}$$

$$f_{bx \oplus}^{D.L.} = \frac{1.31 \times 12}{5.11} = 3.08 \text{ ksi}$$

$$f_{bx \oplus}^V = 1.67 \times 3.08 = 5.14 \text{ ksi}$$

$$f_a^T = \frac{2.25}{2.4 \times 2} = 0.47 \text{ ksi}$$

$$f_a^L = 4.25 / (2.4 \times 2) = 0.89 \text{ ksi}$$

$$f_{by \oplus}^L = \frac{23.83}{12.11} = 1.97 \text{ ksi}$$

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 input and results of similar codes

F-166, 7-82

| Revision | Original Issue | Date | Rev. 5 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCC | 2/18/12 | | | | | | |
| Checker | | | GRT | 9/25/14 | | | | | | |

Question - 2.1.3 (cont)

STRESSES @ TOP F-LET OF WEB OF VERT.
CHANNEL IS CRITICAL.

$$f_{bx}^{DL} = f_{bx}^{AL} \times \frac{(6-3.201-13/16)}{(6-3.201)}$$

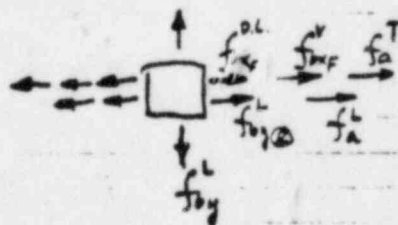
$$= 3.08 \times 0.7097 = 2.19 \text{ ksi}$$

$$f_{bx}^V = f_{bx}^V \times 0.7097$$

$$= 5.14 \times 0.7097 = 3.65 \text{ ksi}$$

$$f_a^T = 0.47 \text{ ksi}, f_a^L = 0.89 \text{ ksi}$$

$$f_{by}^L = 1.97 \text{ ksi}, f_{by}^L = 8.93 \text{ ksi}$$



$$\left(\frac{xL}{r}\right)_x = \frac{2 \times 4.42 \times 12}{1.713} = 62. \Rightarrow F_a = 17.24 \text{ ksi}$$

$$F_{bx} = \frac{1000 \times 12}{9.1 \times 4.42 \times 12} = 24.9 \text{ ksi} \quad \text{USE } 22. \text{ ksi}$$

$$f_a^L / F_a = 0.89 / 17.24 = 0.052 < 0.15$$

AISC 1.6-2 FOR SEISMIC

$$\frac{2.19}{22} + \sqrt{\left(\frac{3.65}{22}\right)^2 + \left(\frac{0.47}{17.24}\right)^2 + \left(\frac{0.89}{17.24} + \frac{1.97}{22}\right)^2 + \left(\frac{8.93}{27}\right)^2}$$

$$= 0.50 < 1.0$$

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 SPLITTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-10/C SET3 Sheet No. 26/

| Revision | Original Issue | Date | Rev. 5 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCC | 2/28/84 | | | | | | |
| Checker | | | SET | 7/25/84 | | | | | | |

Question 2.1.3 (cont)

STRESSES @ TOP FLANGE OF VERT. CHANNEL.

$$f_{bx}^{D.L.} = 3.08 \text{ ksi}$$

$$f_{bx}^V = 5.14 \text{ ksi}$$

$$f_a^T = 0.47 \text{ ksi}, f_a^L = 0.89 \text{ ksi}$$

$$f_{by}^L = 1.97 \text{ ksi}$$

$$f_{by}^L = 8.93 \times \frac{(0.5625 + \frac{1}{16} - 0.343)}{0.5625} \times \left(\frac{0.2}{0.343}\right)^2 = 5.57 \text{ ksi}$$

AISC 1.6-2 FOR SEISMIC.

$$\frac{3.08}{22}_{D.L.} + \sqrt{\left(\frac{5.14}{22}\right)^2 + \left(\frac{0.47}{17.24}\right)^2 + \left(\frac{0.89}{17.24} + \frac{1.97}{22}\right)^2 + \left(\frac{5.57}{27}\right)^2}$$

$$= 0.483 < 1.0 \text{ O.K.}$$

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 SUPPLIES - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-10/C SET 3 Sheet No. 262

| Revision | Original Date | Date | Rev. | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|---------------|------|------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | scs | 9/15/84 | | | | | | |
| Checker | | | GRT | 9/25/84 | | | | | | |

Question 21.3 (cont)

CHECK BUILT-UP BEAM @ SECT ①-②:

Stresses @ Top fillet of web of vertical channel is critical, by proportion

$$f_{bx}^{DL} = \frac{1.25}{2.83} \times f_{bx}^{DL} = \frac{1.25}{2.83} \times 3.08 = 1.36 \text{ ksi}$$

$$f_{bx}^{T} = 1.67 \times 1.360 = 2.27 \text{ ksi}; f_a^T = 0.47 \text{ ksi}$$

$$f_{bx}^{DL} = 1.36 \times 0.7097 = 0.97 \text{ ksi}; f_a^L = 0.89 \text{ ksi}$$

$$f_{bx}^{DL} = 2.27 \times 0.7097 = 1.611 \text{ ksi}; f_{by}^L = 8.93 \text{ ksi}$$

$$M_{xy}^L = \left(\frac{3.92}{2} \times \frac{2.17}{4.67} \right) \times 16 = 14.57 \text{ in-k}$$

$$f_{by}^L = \frac{14.57}{12.11} = 1.20 \text{ ksi}$$

AISC 1.6-2 for Seismic

$$\frac{0.97}{22} + \sqrt{\left(\frac{1.611}{22} \right)^2 + \left(\frac{0.47}{17.24} \right)^2} + \left(\frac{0.89}{17.24} + \frac{1.2}{22} \right)^2 + \left(\frac{8.93}{27} \right)^2}$$

$$= 0.40 < 1.0 \text{ O.K.}$$

∴ Built-up beam is adequate

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. 175

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | scg | 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

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. 176

| Revision | Original Issue | Date | Rev. 4 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | scch | 9-22-84 | | | | | | |
| Checker | | | VAC | 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 & beams 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.

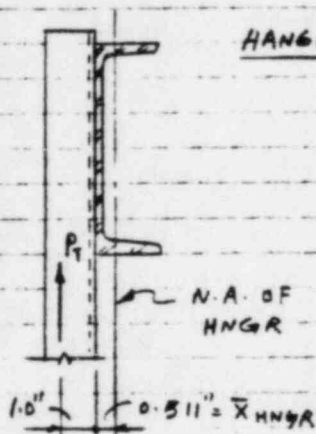
F-166, 7-82

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 Date | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|---------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | MC | 9-19-84 | | | | | | |
| Checker | | | SCS | 9-16-84 | | | | | | |

QUESTION 2.2 (CONT'D)

- i) EFFECT OF ECCENTRIC CONN. FOR THE TRANSVERSE LOADS:
 REFER TO THE STIFFNESS ANALYSIS SHOWN ON SH. 156 TO 158 R.4



HANGER $\Delta M^T = P_T \times \frac{L}{12}$
 REF. TO SH. 160 R.4
 $\Delta P_T = 0.2322 \Delta M^T = 0.2322 P_T \times \frac{L}{12}$
 $= 0.0193 L P_T$

$\frac{\Delta P_T}{P_T} = 0.0193 L$ (ALSO REFER TO SH. 161 R.4)

FROM LOAD P_T TO C.G. OF HANGER, $L = 1.0 + 0.511$
 $= 1.511 \text{ IN.}$

PLAN

$\frac{\Delta P_T}{P_T} = 0.0193 \times 1.511 = 0.029$
 $= 2.9 \%$

TRAY $\frac{\Delta M_y^T}{M_y^T} = 0.081 L$ (REFER TO SH. 161 R.4)
 $= 0.081 \times 1.511 = 0.122$
 $= 12.2 \%$

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

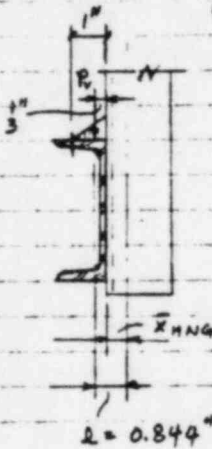
| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | MC | 9-19-84 | | | | | | |
| Checker | | | SCS | 9-26-84 | | | | | | |

GUES. 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

$$\frac{\Delta P_v}{P_v} = 0.01932$$

$$= 0.0193 \times 0.844 = 0.0163$$

$$= 1.63 \%$$

TRAY

$$\frac{\Delta M_x^V}{M_x^V} = 0.0812$$

$$= 0.081 \times 0.844 = 0.068$$

$$= 6.8 \%$$

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 | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | MC | 9-19-84 | | | | | | |
| Checker | | | SCS | 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)

$$\begin{aligned} \text{TRAY GF-36SL: } & 1.6 \left[\frac{105 \times 1.068}{925} + \sqrt{\left(\frac{2.61 \times 105 \times 1.068}{925} \right)^2 + \left(\frac{3.38 \times 105 \times 1.122}{1010} \right)^2 + \left(\frac{3.38 \times 105}{2 \times 5588} \right)^2} \right] \\ & = 1.6 \left[0.1212 + \sqrt{0.10012 + 0.15544 + 0.00103} \right] \\ & = 1.004 \approx 1.0 \end{aligned}$$

$$* P_c = \frac{2 \pi^2 E I}{L^2}$$

SEE SCS-111C SET 7
 SH. 4 & 5 R.0

TRAY GG-12SL-12-06-CP:

$$\begin{aligned} & 1.6 \left[\frac{35 \times 1.068}{265} + \sqrt{\left(\frac{2.61 \times 35 \times 1.068}{265} \right)^2 + \left(\frac{3.38 \times 35 \times 1.122}{424} \right)^2 + \left(\frac{3.38 \times 35}{2 \times 1295} \right)^2} \right] \\ & = 1.6 \left[0.1411 + \sqrt{0.13554 + 0.0980 + 0.00209} \right] = 1.002 \approx 1.0 \end{aligned}$$

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. 7323 Client TUGCO

Subject CABLE TRAY SUPPLIES - 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 # | | | 1 | | | | | | | |
| Preparer | | | Scch | 9.22.84 | | | | | | |
| Checker | | | W.C. | 9.26.84 | | | | | | |

Question 2.2 (cont)

TRAY GG-24SL-12-06 :

$$1.6 \left[\frac{70 \times 1.068}{675} + \sqrt{\left(\frac{2.61 \times 70 \times 1.068}{675} \right)^2 + \left(\frac{3.32 \times 70 \times 1.122}{650} \right)^2 + \left(\frac{3.38 \times 70}{2 \times 4,075} \right)^2} \right]$$

$$= 1.6 \left[0.1108 + \sqrt{0.0836 + 0.1668 + 0.00084} \right]$$

$$= 0.98 < 1.0 \quad \text{O.K.}$$

∴ All types of cable trays are adequate

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPLYS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCS-101C SET 1 Sheet No. 181

| Revision | Original Issue | Date | Rev. 1 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | SCS | 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 & 4 for conclusion.

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. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | SCS | 9-24-94 | | | | | | |
| Checker | | | WC | 9-26-94 | | | | | | |

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 supports cases L-A_i, L-B_i & L-C_i
4. Effects on other generic supports are minor as illustrated in the table below.

| SUPPORT CASES $i = 1 \text{ to } 4$ | HANGER | | BEAM | | | | REMARKS (Ref. to Sh. 162 & 163 RS) |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|---|
| | σ_{Pr}/P_r | σ_{Pr}/P_r | @ END | | @ BOLT HOLE | | |
| | | | σ_{Pr}/P_r | σ_{Pr}/P_r | σ_{Pr}/P_r | σ_{Pr}/P_r | |
| A_i, B_i, C_i | 1.63% | 2.9% | 1.39% | 1.09% | 1.39% | 3.49% | $\textcircled{1} 9.0005 \times 1.0/104-1 = 1.09\%$ $\textcircled{2} 1.0242 \times 1.0/104-1 = 3.49\%$ ★ |
| $D_i, D_i \text{ w/BR}$ | 1.63% | 1.06% | 1.39% | 1.54% | * | * | $\textcircled{1} 1.0002 \times 1.0/104-1 = 1.06\%$ $\textcircled{2} 1.0049 \times 1.0/104-1 = 1.54\%$ |

- *: 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.

$$\text{MOMENT @ END} = M^T \text{ K-K}$$

$$f_{bx @ \text{END}} = M^T / 2.29 = 0.4367 M^T \text{ ksi}$$

$$f_{bx @ \text{BOLT}} = (M^T - M^T \times \frac{0.75}{3.0}) \times \frac{1}{1.948} = 0.385 M^T \text{ ksi} < 0.4367 M^T \text{ ksi}$$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPLS - 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 |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| 1 | | | 1 | | | | | | | |
| Checking Method # | | | SCC | 9-24-84 | | | | | | |
| Prepared | | | W.C. | 9-26-84 | | | | | | |
| Checked | | | | | | | | | | |

Purpose: To verify adequacy of the tray support case D1 including effects due to eccentric loads & connections

References:

1. Letter P4056.031 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 I_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 D1.

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. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 9/8/84 | | | | | | |
| Checker | | | VIC | 9-26-84 | | | | | | |

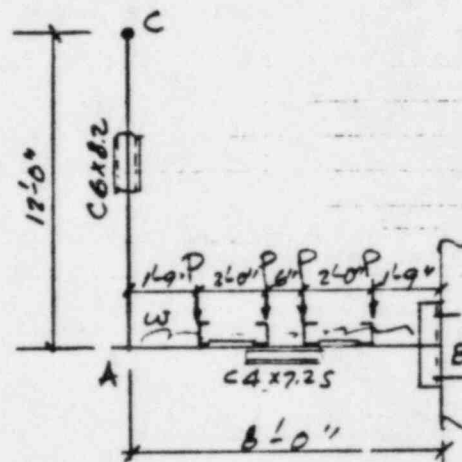
CASE D1:

$$\frac{I_x}{l} \Big|_{AC} = \frac{13.1}{12} = 1.092 = K_{AC}$$

$$\frac{I_x}{l} \Big|_{AB} = \frac{4.59}{8} = 0.5738 = K_{AB}$$

$$DF_{AC} = \frac{1.092 \times 0.75}{0.5738 + 1.092 \times 0.75} = 0.59$$

$$DF_{AB} = 1 - 0.59 = 0.41$$



ELEVATION

DEAD LOAD:

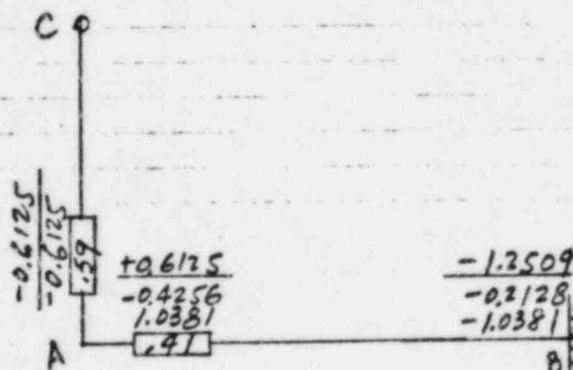
$$P^{DL} = 0.035 \times 2 \times 8.5/2 = 0.2975^k, \quad W^{DL} = 0.00725^k/ft$$

$$M_{AB}^{F,DL} = \frac{1}{12} (0.00725) \times 8^2 = 0.0387^k/ft$$

$$0.2975 \times 1.75 \left(1 - \frac{1.75}{8}\right) = 0.4067$$

$$0.2975 \times 3.75 \left(1 - \frac{3.75}{8}\right) = 0.5927$$

$$1.0381^k/ft$$



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

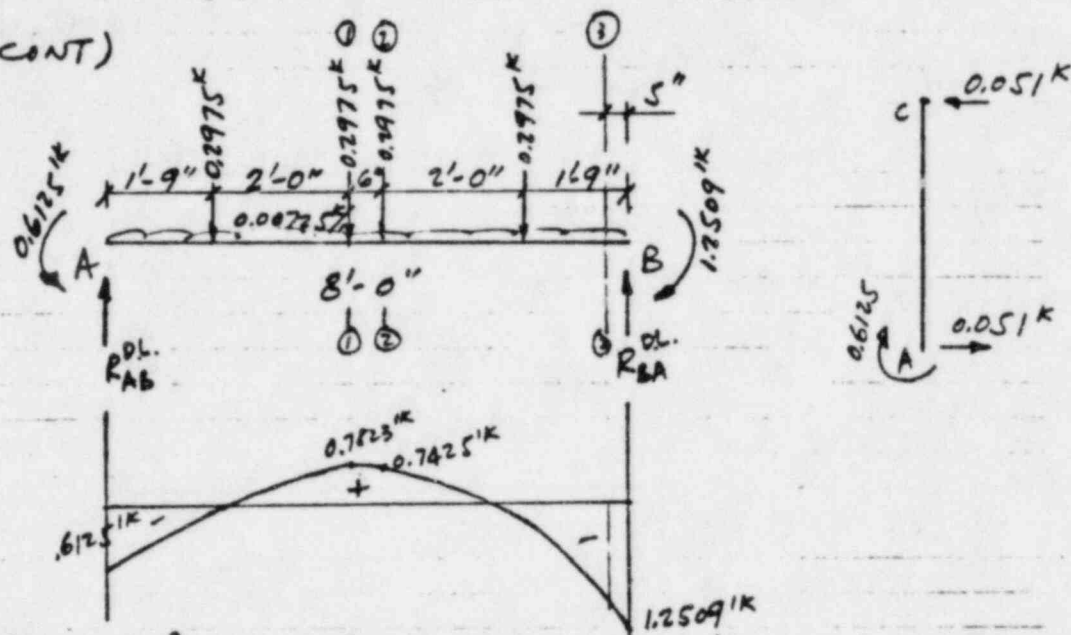
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CABLE TRAY SUPPTS - RESPONSE TO CYGNA PHASE 4 REVIEW

Calculation Number SCS-101C SET 3 Sheet No. 235

| Revision | Original Issue | Date | Rev. 9 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | Secy | 9/8/84 | | | | | | |
| Checker | | | MC | 9-26-84 | | | | | | |

CASE D1 (CONT)



$$R_{AB}^{DL} = \frac{\frac{1}{2}(0.00725)8^2 + 0.2975(1.75 + 3.75 + 4.25 + 6.25) + 0.6125 + 1.2509}{8.0} = 0.5442 \text{ K}$$

$$R_{BA}^{DL} = 0.2975 \times 4 + 0.00725 \times 8 - 0.5442 = 0.7038 \text{ K}$$

$$M_{\text{①-①}}^{DL} = [0.5442 \times 3.75 - 0.6125 - 0.2975 \times 2 - \frac{1}{2}(0.00725) \times 3.75^2] = 0.7823 \text{ K}$$

$$M_{\text{③-②}}^{DL} = [0.5442 \times 4.25 - 0.6125 - 0.2975(0.5 + 2.5) - \frac{1}{2}(0.00725) \times 4.25^2] = 0.7425 \text{ K}$$

$$M_{\text{①-③}}^{DL} = 0.7038 \times \frac{5}{12} - 1.2509 = -0.9577 \text{ K}$$

VERTICAL SEISMIC:

$$M_{AB}^V = -M_{AC}^V = 1.67 \times 0.6125 = 1.0229 \text{ K}$$

$$M_{BA}^V = 1.67 \times 1.2509 = 2.089 \text{ K}; M_{\text{①-①}}^V = 1.67 \times 0.9577 = 1.5994 \text{ K}$$

$$M_{\text{①-③}}^V = 1.67 \times 0.7823 = 1.3064 \text{ K}; M_{\text{③-②}}^V = 1.67 \times 0.7425 = 1.2398 \text{ K}$$

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

F-166, 7-82

| Revision | Original Issue | Date | Rev. 9 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | 1 | | | | | | | |
| Preparer | | | SCS | 9/10/84 | | | | | | |
| Checker | | | W.C. | 9-26-84 | | | | | | |

CASE D, (CONT)TRANSVERSE SEISMIC:MEMBER AC:

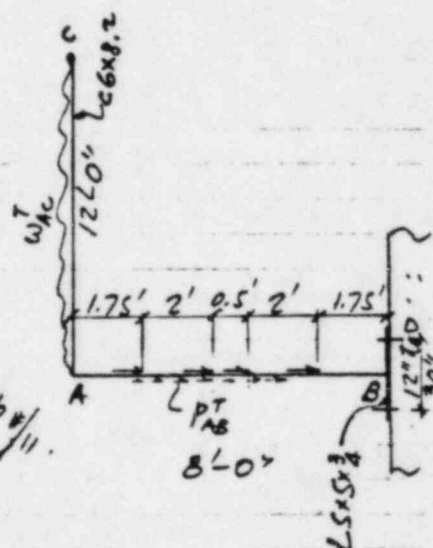
$$\Delta_{max} = \frac{wL^4}{185EI}$$

$$k_{AC} = \frac{(wL)}{\Delta} = \frac{185EI}{L^3}$$

$$= \frac{185 \times 29 \times 10^6 \times 13.1}{(144)^3} = 0.02354 \times 10^6 \text{ #/in.}$$

$$wL = 8.2 \times 12 = 98.4 \text{ #}$$

$$f_{AC} = \frac{1}{2\pi} \sqrt{\frac{k}{M}} = \frac{1}{2\pi} \sqrt{\frac{0.02354 \times 10^6 \times 386.4}{98.4}} = 48.4 \text{ Hz}$$



MEMBER AB IS VERY STIFF TO RESIST THE AXIAL FORCE.

BEAM CONN. @ B:

$$k_b = \frac{P}{\Delta} = \frac{48EI}{L^3} = \frac{48 \times 29 \times 10^6 \times 15.7}{30^3} = 0.8094 \times 10^6 \text{ #/in.}$$

$$P = 0.2975 \times 4 + 0.0082 \times 6 + 0.00725 \times 8 + 0.0236 \times \frac{30}{2 \times 12} = 1.327 \text{ K}$$

$$f_b = \frac{1}{2\pi} \sqrt{\frac{0.8094 \times 10^6 \times 386.4}{1327}} = 77.3 \text{ Hz}$$

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO
 Subject CABLE TRAY SUPPORTS - RESPONSE TO CYGNA PHASE 4 REVIEW
 Calculation Number SCE-101C SET 3 Sheet No. 237

| Revision | Original Issue | Date | Rev. 7 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | MC | 9.25.84 | | | | | | |
| Checker | | | NV | 9.26.84 | | | | | | |

CASE D1 (CONT'D)

CABLE TRAY

$$\text{OVERHANG MOM.} = \frac{1}{2} w a^2 = \frac{1}{2} w \times \left(\frac{2.0}{8.5} l\right)^2 = 0.0277 w l^2$$

$$\text{FIXED END MOM.} = \frac{1}{2} w l^2 = 0.0833 w l^2$$

| | | | | | | | | | | |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|----------------|---------|
| | A | | B | | C | | D | | E | |
| | a | | l | | l | | l | | l = 8.5' + 1A | |
| | | | | | | | | | a = 2.0' - 1P. | |
| L.T. FACTOR | 1.0 | | 3/7 4/7 | | 0.5 0.5 | | 4/7 3/7 | | 1.0 | |
| | -0.0277 | +0.0833 | -0.0833 | +0.0833 | -0.0833 | +0.0833 | -0.0833 | +0.0833 | -0.0833 | +0.0277 |
| | | -0.0556 | | | | | | | +0.0556 | |
| | | | -0.0278 | | | | | +0.0278 | | |
| | | | +0.0119 | +0.0159 | +0.0079 | -0.0079 | -0.0159 | -0.0119 | | |
| | -0.0277 | +0.0277 | -0.0992 | +0.0992 | -0.0754 | +0.0754 | -0.0992 | +0.0992 | -0.0277 | +0.0277 |
| | G | | 2 | G | 2 | G | 2 | G | 2 | |

DEFLECTION: FROM AISC 2-125, 8TH ED.

EXTERIOR SPAN (SPAN DE)

$$M_1 = 0.0992 w l^2$$

$$M_2 = 0.0277 w l^2$$

$$\Delta_x = \frac{w x^2}{24EI} \left[x^3 - (2l + 4 \times 0.0992 l - 4 \times 0.0277 l) x^2 + 12 \times 0.0992 l^2 x + l^3 - 8 \times 0.0992 l^3 - 4 \times 0.0277 l^3 \right]$$

$$= \frac{w x^2}{24EI} \left[x^3 - 2.286 l x^2 + 1.1904 l^2 x + 0.0956 l^3 \right]$$

$$\frac{d\Delta_x}{dx} = \frac{w}{24EI} \left[4x^2 - 6.858 l x + 2.3808 l^2 + 0.0956 l^3 \right] = 0$$

BY TRIAL & ERROR, $x = 0.5474 l$

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. 238

| Revision | Original Issue | Date | Rev. | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|------|---------|------|------|------|------|------|------|
| Checking Method 3 | | | 1 | | | | | | | |
| Preparer | | | MC | 9-25-84 | | | | | | |
| Checker | | | NV | 9-26-84 | | | | | | |

CASE Di (CONT'D)

EXT. SPAN (CONT'D)

$$\text{MAX. } \Delta = \frac{wl^4}{24EI} \times 0.5474 \left[0.5474^3 - 2.286 \times 0.5474^2 + 1.1904 \times 0.5474 + 0.0956 \right]$$

$$= 0.00516 \frac{wl^4}{EI}$$

INTERIOR SPAN (SPAN BC)

$$M_1 = 0.0992 wl^2$$

$$M_2 = 0.0754 wl^2$$

$$\Delta_x = \frac{w(x)}{24EI} \left[(x)^3 - (2l + 4 \times 0.0992l - 4 \times 0.0754l) (x)^2 + 12 \times 0.0992l^2 (x) + l^3 - 8 \times 0.0992l^3 - 4 \times 0.0754l^3 \right]$$

$$= \frac{w(x)}{24EI} \left[(x)^3 - 2.0952l (x)^2 + 1.1904l^2 (x) - 0.0952l^3 \right]$$

$$\frac{d\Delta_x}{dx} = 0 \Rightarrow 4(x)^3 - 6.2856l (x)^2 + 2.3808l^2 (x) - 0.0952l^3 = 0$$

BY TRIAL & ERROR $(x) = 0.5262l$

$$\text{MAX. } \Delta = \frac{wl^4}{24EI} \times 0.5262 \left[0.5262^3 - 2.0952 \times 0.5262^2 + 1.1904 \times 0.5262 - 0.0952 \right]$$

$$= 0.00212 \frac{wl^4}{EI}$$

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

F-166, 7-82

| Revision | Original Issue | Date | Rev. # | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|--------------|--------|--------------|------|--------------|------|--------------|------|--------------|
| Checking Method # | | X | 1 | X | | X | | X | | X |
| Preparer | | | see | 9-25-84 | | | | | | |
| Checker | | | WC | 9-26-84 | | | | | | |

Case D₁ (cont)

exterior span:

$$\Delta_{\text{ext}} = \frac{0.00516 (\text{wl}) (8.5 \times 12)^3}{29 \times 10^6 \times 4.13} = 45.72 \times 10^{-6} (\text{wl}) \quad "$$

$$k_{ext} = \frac{1}{\Delta_{ext}} = 0.02187 \times 10^6 \text{ } \mu\text{in}^{-1}, (wL = 1 \text{ } \mu\text{in})$$

$$wL = 35 \times 2 \times 8.5 = 595 \text{ \#}$$

$$f_c = \frac{1}{2\pi} \sqrt{\frac{0.0287 \times 10^6 \times 386.4}{595}} = 18.97 \text{ Hz}$$

$$\leq f = \frac{1}{\sqrt{\frac{1}{f_{ac}^2} + \frac{1}{f_B^2} + \frac{1}{f_c^2}}} = \frac{1}{\sqrt{\frac{1}{40.4^2} + \frac{1}{77.3^2} + \frac{1}{18.97^2}}} = 17.22 \text{ Hz}$$

$g_{h_{ref}} = 1.249$ Ref. DMI-11C Lot 3 SH19RD

Interior span:

$$k_{int} = \frac{0.00516}{0.00212} \times 0.02187 \times 10^6 = 0.05323 \times 10^6 \text{ #/}$$

$$f_t = \frac{1}{2\pi} \sqrt{\frac{0.05323 \times 10^6 \times 3864}{595}} = 29.6 \text{ Hz}$$

$$\Sigma f = \frac{1}{\sqrt{\frac{1}{48.4^2} + \frac{1}{77.3^2} + \frac{1}{29.6^2}}} = 24.0 \text{ Hz}$$

$$\Rightarrow g_{h_{int}} = 0.82$$

$$g_{avg} = \frac{1}{2} (g_{ext} + g_{int}) = \frac{1}{2} (1.249 + 0.82) = 1.035$$

USE $g_L = 1.05$

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 # | | | SCS | 9/8/84 | | | | | | |
| Preparer | | | ML | 9-26-84 | | | | | | |
| Checker | | | | | | | | | | |

CASE D1 (CONT)

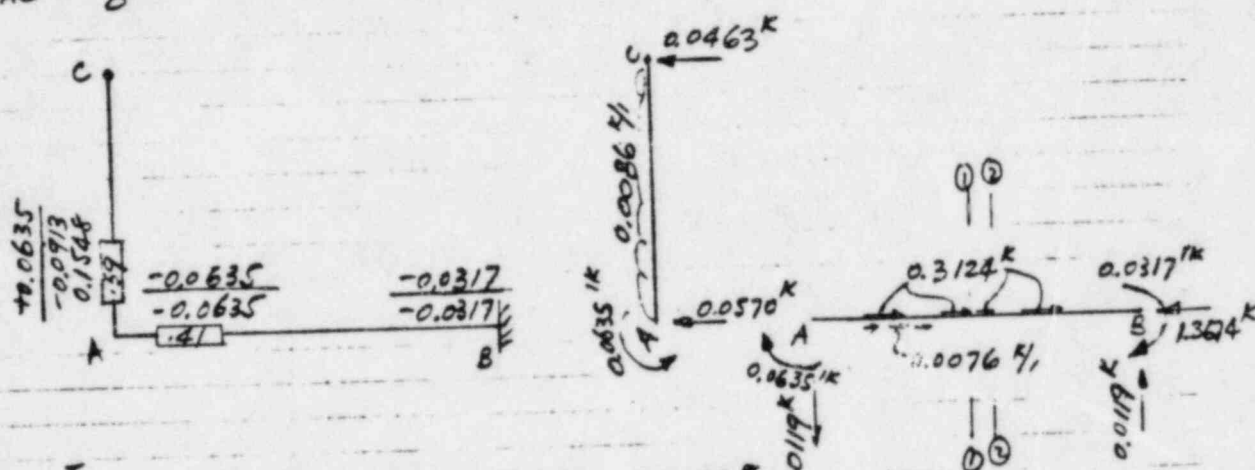
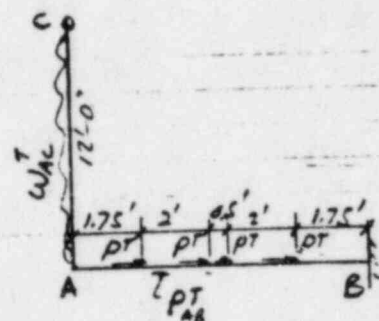
TRANSVERSE SEISMIC:

$$W_{AC}^T = 1.05 \times 0.0082 = 0.0086 \text{ K/}$$

$$P_{AB}^T = 1.05 \times 0.00725 = 0.0076 \text{ K/}$$

$$P^T = 1.05 \times P^{D.L.} = 1.05 \times 0.2975 = 0.3124 \text{ K}$$

$$M_{AC}^{F,T} = \frac{1}{8} (0.0086) (12)^2 = 0.1548 \text{ IK}$$



$$M_{0-1}^T = -0.0635 + 0.0119 \times 3.75 = -0.0189 \text{ K}$$

$$M_{1-2}^T = -0.0635 + 0.0119 \times 4.25 = -0.0129 \text{ K}$$

$$M_{2-3}^T = 0.0119 \times \frac{5}{12} - 0.0317 = -0.0267 \text{ K}$$

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

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. 241

| Revision | Original Issue | Date | Rev. 9 | Date | Rev. | Date | Rev. | Date | Rev. | Date |
|-------------------|----------------|------|--------|---------|------|------|------|------|------|------|
| Checking Method # | | | | | | | | | | |
| Preparer | | | Sec | 9/8/84 | | | | | | |
| Checker | | | MC | 9-26-84 | | | | | | |

CASE 'D1' (CONT)

CHECK HGR C6X8.2

$$P_{AC}^{DL} = R_{AB}^{DL} + 0.0092 \times 12 = 0.5442 + 0.0984 = 0.6426^K$$

DOWNWARD SEISMIC

$$\Sigma P_{AC} = 0.6426 + \left[(0.6426 \times 1.67)^2 + 0.0119^2 \right]^{1/2} = 1.716^K \text{ TENSION}$$

$$\Sigma M_{AC} = 0.6125 + (1.0229^2 + 0.0635^2)^{1/2} = 1.6372^{1K}$$

$$F_{bx} = \frac{12 \times 10^3}{12 \times 12 \times 9.1} = 9.16 \text{ ksi}$$

$$f_a = 1.716 / 2.4 = 0.715 \text{ ksi (TENSION)}; f_{bx} = \frac{1.6372 \times 12}{4.38} = 4.49 \text{ ksi}$$

AISC 1.6-1b

*Ref to SCS-101C Set 1
Sh 1P2 R4

$$\left(\frac{0.715}{22} + \frac{4.49}{9.16} \right) \times 1.0163 = 0.532 < 1.0$$

O.K.

UPWARD SEISMIC:

$$\Sigma P_{AC} = +0.6426 - \left[(0.6426 \times 1.67)^2 + 0.0119^2 \right]^{1/2} = -0.431^K \text{ (COMP.)}$$

$$\Sigma M_{AC} = +0.6125 - (1.0229^2 + 0.0635^2)^{1/2} = -0.412^{1K}$$

$$f_a = 0.431 / 2.4 = 0.18 \text{ ksi}; f_{bx} = \frac{0.412 \times 12}{4.38} = 1.13 \text{ ksi}$$

$$\left(\frac{KL}{r} \right)_y = \frac{0.7 \times 12 \times 12}{0.537} = 187.7 \Rightarrow F_a = 4.24 \text{ ksi}$$

$$f_a / F_a = 0.18 / 4.24 = 0.0425 < 0.15$$

$$\text{AISC 1.6-2} \quad \left(0.0425 + \frac{1.13}{9.16} \right) \times 1.0163 = 0.169 < 1.0 \text{ O.K.}$$

HGR C6X8.2 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 SUPPLIES - 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 | | | SCS | 9/10/84 | | | | | | |
| Checker | | | MC | 9-26-84 | | | | | | |

CASE D1 (CONT)

CHECK BEAM C4x7.25:

@ point B: CRITICAL

$$\Sigma P_{AB \max} = 0.051 + [(0.051 \times 1.67)^2 + 1.3674^2]^{1/2} = 1.421^K$$

$$\Sigma M_{BA} = 1.2509 + (2.089^2 + 0.0317^2)^{1/2} = 3.34^K$$

$$f_a = 1.421 / 2.13 = 0.667 \text{ ksi}$$

$$f_{bx} = \frac{3.34 \times 12}{2.29} = 17.5 \text{ ksi}$$

$$\left(\frac{KL}{r}\right)_y = \frac{1.0 \times (24 + 2.625)}{0.45} = 59.2 \quad \text{GOVERN} \quad F_a = 17.5 \text{ ksi}$$

$$\left(\frac{KL}{r}\right)_x = \frac{0.65 \times 8 \times 12}{1.47} = 42.4$$

$$f_a / F_a = 0.667 / 17.5 = 0.0381 < 0.15$$

$$F_{by} = \frac{12 \times 1000}{26.625 \times 7.84} = 57.5 \text{ ksi} \quad \text{USE } 22. \text{ ksi}$$

AISC 1.6-2

$$(0.0381 + \frac{17.5}{22}) \times 1.0154 = 0.846 < 1.0 \quad \text{O.K.}$$

@ Bolt hole Location:

compare the moment (O.L.) & the properties

$$\frac{0.7823^K @ \text{bolt}}{1.2509^K @ \text{pt. B}} = 0.6254 < \frac{1.948}{2.29} = 0.8507 \text{ O.K.}$$

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 SUPPTS - 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 # | | | | | | | | | | |
| Preparer | | | See 5 | 9/10/84 | | | | | | |
| Checker | | | m.c. | 9-26-84 | | | | | | |

CASE D₁ (CONT)

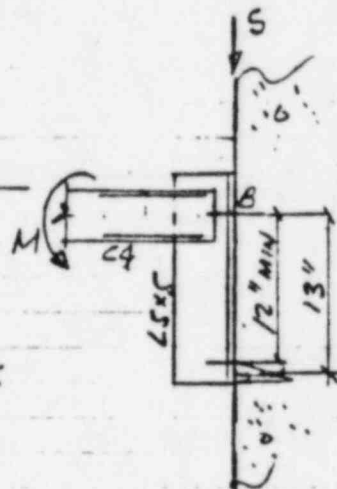
BGM CONN. @ WALL:

$$P_a^{DL} = 0.051^k; M_a^{DL} = 1.2509^k; S_a^{DL} = 0.7038^k$$

$$P_a^V = 0.085^k; M_a^V = 2.089^k; S_a^V = 1.1753^k$$

$\downarrow 0.051 \times 1.67$ $\downarrow 0.7038 \times 1.67$

$$P_a^T = 1.3674^k; M_a^T = 0.0317^k; S_a^T = 0.0119^k$$



$$T^{DL} = \frac{0.051 \times 10.5}{12.0} + \frac{1.2509 \times 12}{13} = 1.1993^k/\phi$$

$$T^V = 1.67 T^{DL} = 2.0028^k/\phi$$

$$T^T = 1.3674 + \frac{0.0317 \times 12}{13} = 1.397^k/\phi$$

$$\Sigma T = 1.1993 + (2.0028^2 + 1.397^2)^{1/2} = 3.641^k/\phi$$

$$\Sigma S = [0.7038 + (1.1753^2 + 0.0119^2)^{1/2}] / 2 = 0.9396^k/\phi$$

1"φ x 7" EMB. H.K.B.

$$\left(\frac{3.641 \times 1.5}{5.5} + \frac{0.9396}{5.4} \right) \times \frac{4}{5} = 0.934 < 1.0$$

\downarrow FS=4.0

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
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F-166, 7-82