442

RELATED CORRESPONDENCE

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December 3, 1984

Geary Mizuno, Esquire
U.S. Nuclear Regulatory Commission
7735 Old Georgetown Road
Room 10107
Bethesda, MD 20814

Subj: Texas Utilities Electric Company, et al.
(Comanche Peak Steam Electric Station,
Unit 1 & 2); Docket Nos. 50-445 and 50-446 OL

Dear Geary:

Enclosed is additional information responding to the NRC Staff's questions concerning Applicants' motions for summary disposition on pipe support design issues. Applicants provided responses to most Staff questions under cover letter of September 24, 1984. The enclosed additional information responds to all the Staff's questions left open in our September 24 response except for those concerning generic stiffness. Information regarding that topic will be provided shortly.

We are also reviewing the transcripts of the August 8-9 and August 23, 1984 meetings to verify that we have responded to all Staff questions. Please let me know if you are aware of any information except that noted above which we still owe the Staff from those meetings.

Sincerely,

William A. Horin

William A. Horin
Counsel for Applicants

8412040266 841203
PDR ADOCK 05000445
G PDR

cc: w/encl. Juanita Ellis
w/o encl. Remainder of Service List

DS02

SUPPLEMENT TO APPLICANTS' SEPTEMBER 24, 1984
RESPONSE TO NRC QUESTIONS FROM MEETINGS
OF AUGUST 8-9 AND AUGUST 23, 1984

C. Axial Restraints

a) As we committed in our September 24, 1984, reply we have performed an evaluation of local stresses in the pipe at pipe support location FW-1-098-007-C62R. This analysis found those stresses to be within allowable stress limits.

Our evaluation was conducted by modelling the single cross-web trapeze attachment with a sufficiently long portion of complete pipe through the use of bending and stretching quadrilateral finite elements (see Figure 1). The model was then subjected to the appropriate transverse forces and torsional moments.

The largest stress computed from local effects only is 42.6 ksi of which 12.8 ksi represents the membrane portion of the stress, with the remainder being bending. These stresses were then combined with the general stresses from the piping analysis, as required in Attachment D8 of Gibbs & Hill Specification AB-2 titilted "Integral Welded Attachment, ASME Code Class 2 and 3 Piping Verification Procedures". Actual values of Sc and Sh were computed from the certified mill test report for the SA333, Grade 6 material used in the piping fabrication. The minimum yield strength of the material certified in that report is 44.6 ksi and the minimum ultimate strength is 67.9 ksi.

The following is a summary of the calculations which demonstrate the acceptability of these stresses (all values are psi).

8') $S_{SL} + S'_{SL} \leq Sh$

$4632 + 405 \leq 19110$

$5037 \leq 19110$

9') $S_{OL} + S'_{OL} \leq 1.5\ Sh$

$5120 + 1204 \leq 1.5\ (19110)$

$6324 \leq 28665$

$S_{OL} + (S'_{OL} + S''_{OL}) \leq 1.8\ Sh$

$5120 + (10014) \leq 1.8\ (19110)$

$15134 \leq 34398$

9'e) $S_{OL} + S'_{OLE} \leq 2.16\ Sh$

$5345 + 12798 \leq 2.16\ (19110)$

$18143 \leq 41278$

NOTE: S'_{OLE} includes seismic anchor movements and faulted condition water hammer for conservatism.

11') $S_{SL} + S_{TE} + S'_{SL} + S'_{TE} \leq S_A + Sh$

$4632 + 6403 + 405 + 30030 \leq 28670 + 19110$

$41470 \leq 47780$

D. Local Displacement & Stresses

a) Further justify why stresses would be greater for the example chosen in the affidavit on p. 5 and 6 than for other configurations.

To assure Applicants fully satisfy the Staff's inquiry, Applicants have chosen to assess all remaining zero clearance box frames. The results of the analyses are summarized in Attachment A. To calculate the pipe stiffness, we have utilized a formula from Roark, "Formulas for Stress and Strain," Table 17, Case 1. That formula, which is directly applicable to a circular ring subjected to opposite point loading, has been modified by linear superposition to reflect the four point loading which occurs in the box frame.

In addition, because the formula is for a ring of unit length, its correspondence to the actual piping configuration requires the determination of an effective length of a ring. This determination was made by comparing the deflections predicted by the ring formula for 4 point loading, to the deflections predicted by finite element analyses of piping of radius and thickness equal to those of the ring. Equating the finite element deflection to that computed by the ring formula enables the determination of the effective length of the ring, i.e., the length which would result in an effective moment of inertia, which when used in the ring formula results in prediction of deflections which are the same as those given by the finite element analyses.

The effective length of pipe used in the formula as a function of pipe radius is given in the curve on page 4 of Attachment A. This curve applies to schedule 40 pipe, which is the pipe size for all but one zero clearance box frame. That exception is one schedule 80 pipe. In that instance the finite element analysis results were used directly in the stiffness computation. The effective length of the ring which would produce the equivalent stiffness when employing the ring formula for the schedule 80 pipe is shown as the single point in the figure on page 4 of Attachment A.

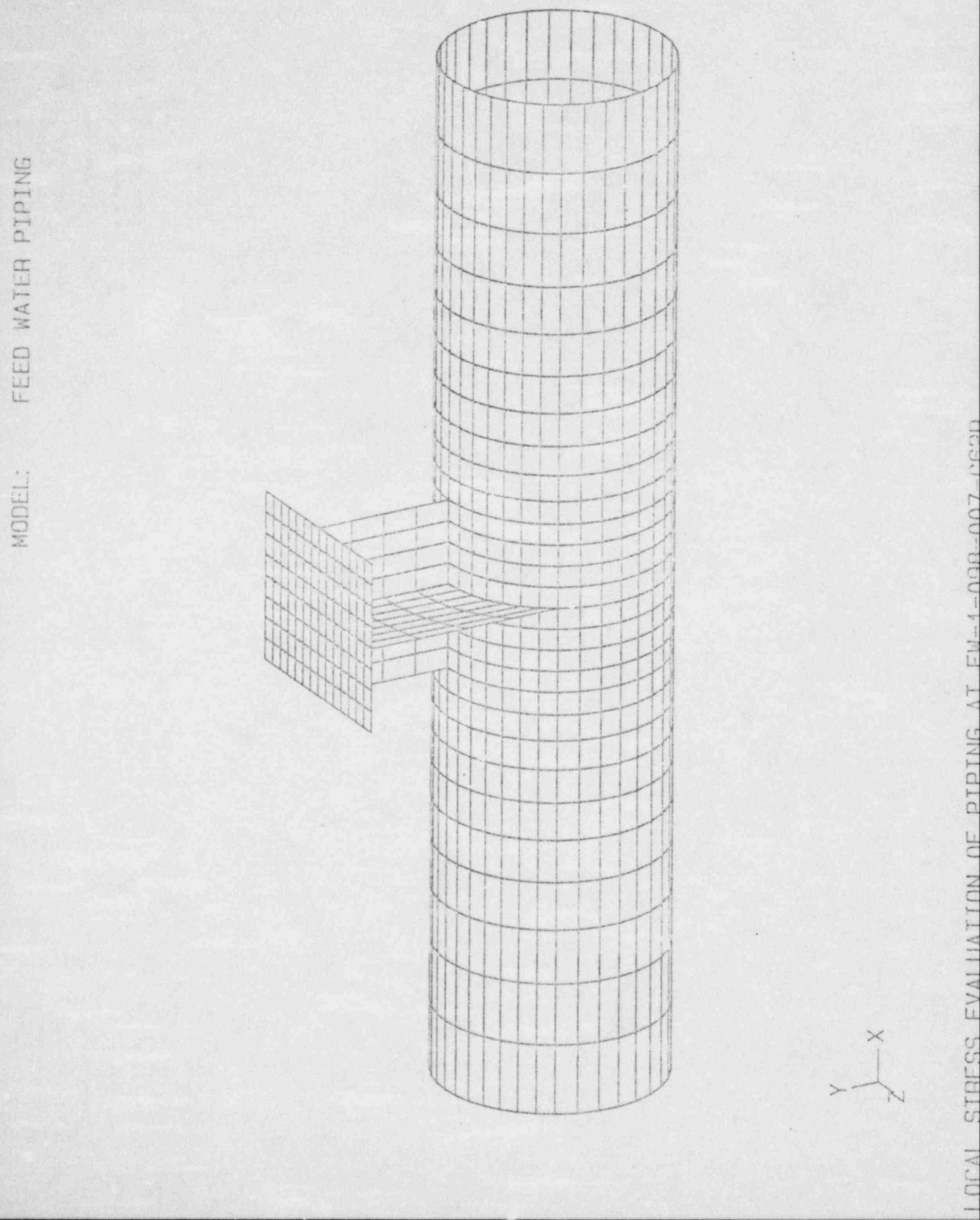
In the summary table for the results of this study, we have listed the resultant load between the pipe and the frame. We have also calculated the resultant pipe stresses and frame stresses. All of these stresses are acceptable. We note that we have identified one additional frame than that notied in our motion which has a maximum pipe temperature in excess of 200° (see item 20 on the summary list: pipe temperature 243°).

d) Enclosed are revised calculations C', D' and E' as referenced on page 38 of Applicants' September 24, 1984, response. Also on that page we noted our intent to provide justification for including the pad thickness when computing pipe stresses. Attachment B contains information providing such justification. As can be seen from this Attachment it is quite reasonable to include pad thickness in the pipe stress calculations if the pad

extends a distance .61 Rt past the trunnion. Applicants' examples C and D don't quite meet that requirement, so we have used alternate means of evaluating pipe stress in C' and D', and the results are essentially the same. Thus, Applicants' original as umption of including pad thickness is justified.

It must be pointed out that on all of these items, the stress evaluation has been performed without the benefit of any real guidance from the ASME Code regarding local stresses resulting from welded and non-welded attachments. When assessing the local stresses, therefore, we have utilized the conservative procedure of Gibbs & Hill which was attached as Attachment D8 to our prior answer.

Figure 1


MODEL: FEED WATER PIPING
X
Y
Z
LOCAL STRESS EVALUATION OF PIPING AT FW-1-098-007

Attachment "B"

FORM DHE-5

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

Date: 8.25.84.
Calc By: T. Kuo
Chk'd/Apprd. By: DYC 10-16-84
Subject:

Filing Code:
Sheet No. 1 of 4
G & H Job. No.
Ref. Dwg./Spec. No.

THE JUSTIFICATION OF INCLUDING THE PAD THICKNESS WHEN COMPUTING PIPE STRESSES.

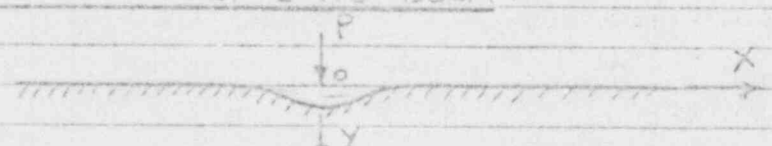
REFER TO 'THEORY AND DESIGN OF MODERN PRESSURE VESSELS' 2nd EDITION BY JOHN F. HARVEY.
PUBLISHED BY VAN NOSTRAN REINHOLD COMPANY

- CHAPTER 4, 'DISCONTINUITY STRESSES IN PRESSURE VESSELS'
- CHAPTER 6, SECTION 6.6 'THEORY OF REINFORCED OPENING'

THE CLASSICAL THEORY OF COMPUTING THE LOCALIZED STRESS (OR DISCONTINUITY STRESSES) ON PIPE (AS A PRESSURE VESSEL) IS THE SAME AS BEAM ON ELASTIC FOUNDATION.

BEAM ON ELASTIC FOUNDATION

A). THE INFINITELY LONG BEAM



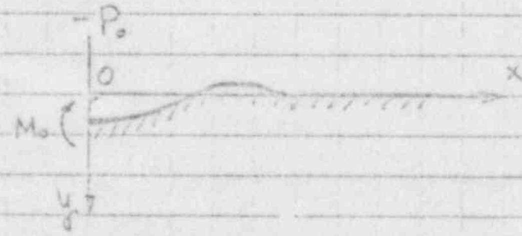
$y = e^{-\beta x}(C_3 \cos\beta x + C_4 \sin\beta x)$ WHERE $\beta = \sqrt[4]{\frac{K}{4EI}}$

K = SPRING CONSTANT.

EQUATION CAN BE SOLVE AS,

$$\begin{cases} y = \frac{P\beta}{2K} e^{-\beta x}(\cos\beta x + \sin\beta x) \\ \frac{dy}{dx} = \theta = -\frac{P\beta^2}{K} e^{-\beta x} \sin\beta x. \\ \frac{d^2y}{dx^2} = M = \frac{P}{4\beta} e^{-\beta x}(\cos\beta x - \sin\beta x) \end{cases}$$

B). THE SEMI-INFINITE BEAM



FORM DHE-5

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

Date 8.26.84
Calc By T. KUO
Chk'd/Apprd. By DVC 10.16.84
Filing Code
Sheet No. 2 Of 4
G & H Job. No.
Subject
Ref. Dwg./Spec. No

THE DEFLECTION AND SLOPE ARE A MAXIMUM AT $x=0$.

$$Y_{max} = \frac{2P_0\beta}{K} - \frac{2M_0\beta^2}{K}$$

$$\theta_{max} = -\frac{2P_0\beta^2}{K} + \frac{4M_0\beta^3}{K}$$

WHERE.

K : SPRING CONSTANT

$$\beta = \sqrt[4]{\frac{K}{4EI}}$$

FOR CYLINDER VESSEL APPLICATION

USING $D = EI = \frac{Et^3}{12(1-\mu^2)}$ FOR VESSELS

FLEXUAL RIGIDITY

AND LET SPRING CONSTANT, & $\mu = 0.3$

$$K = \frac{Et}{r^2}$$

THUS

$$\beta = \sqrt[4]{\frac{K}{4EI}} = \sqrt[4]{\frac{Et}{r^2} \Big/ \frac{4Et^3}{12(1-\mu^2)}}$$

$$= \sqrt[4]{\frac{3(1-\mu^2)}{r^2 t^2}} = \frac{1.2854}{\sqrt{rt}}$$

REFER TO JOHN F. HARVEY'S 'THEORY AND DESIGN OF MODERN PRESSURE VESSEL'. SECTION 4.6.

FROM FIG. 4.1 (ATT. I), THAT THE VALUE OF DEFLECTION, SLOPE, BENDING MOMENT AND SHEAR ALL HAVE THE CHARACTERISTIC DAMPED WAVE FORM OF RAPIDLY DIMINISHING AMPLITUDE.

FORM DHE-5

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

Date 8.26.84
Calc By T. KUO
Chk'd/Apprd. By DYC 10.16.84

Filing Code
Sheet No. 3 Of 4
G & H Job. No.

Subject ______ Ref. Dwg./Spec. No.

THE LENGTH OF THIS WAVE CAN BE WRITTEN AS.

$$a = \frac{2\pi}{\beta} = 2\pi \sqrt[4]{\frac{EI}{K}}$$

β IS CALLED THE 'DAMPING FACTOR', IT IS NOTED THAT THESE VALUES ARE VERY SMALL AT ABOUT A DISTANT OF $x = \pi/\beta$ ON EITHER SIDE OF THE LOAD. IN ANOTHER WORD THAT IF THE BEAM LENGTH EQUAL TO $2\pi/\beta$ WILL HAVE ESSENTIALLY THE SAME DEFLECTION, SLOPE, BENDING MOMENT AND SHEAR CURVE AS AN INFINITELY LONG BEAM

ON CYLINDRICAL STEEL VESSEL THEN, OF LENGTH GREATER THAN $2\pi\sqrt{r.t}/1.2854 = 4.9\sqrt{rt}$

ACTS AS IT WERE INFINITE LONG. BEAM ON ELASTIC FOUNDATION THEORY OF INFINITELY LONG BEAM EQUATION MAY BE USED.

- THE OBSERVATION THAT CAN BE MADE FROM THE NATURE OF THE CURVES OF FIG. 4.1 (ATT. I) IS THE DISTANCE BEYOND THE APPLICATION OF THE LOAD AT WHICH STRUCTURAL REINFORCING OF THE PIPE MAY BE ASSUMED TO HAVE NO SIGNIFICANT EFFECT.

AS PER FIG. 4.1 e (ATT. 1) MOMENT CURVE WILL DIMINISH AT LENGTH OF $x = \frac{\pi}{4\beta}$ ON EITHER SIDE OF LOAD.

$$\text{OR } x = \frac{\pi}{4} \times \frac{\sqrt{r\,t}}{1.2854} = 0.61\sqrt{r\,t}.$$

WHERE r: RADIUS OF CYLINDER VESSEL
t: THICKNESS OF VESSEL.

TEXAS UTILITIES SERVICES INC.
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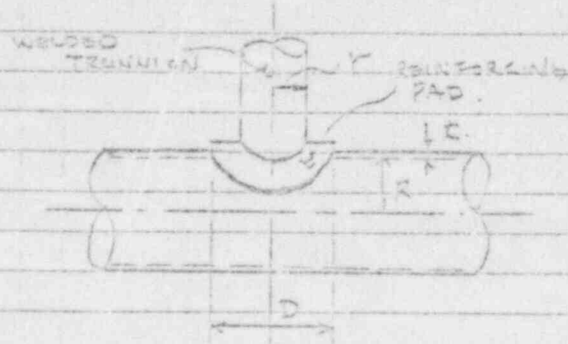
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 8.26.84
Calc By T. KUO
Chk'd/Appr. By DYC 10-16-84
Subject
Ref. Dwg. Spec. No.
Filing Code

G & H Job No.

WHEN REINFORCING PAD IS REQUIRED IN DESIGN APPLICATION, THE SIZE OF THE PAD HAS MINIMUM DIAMETER OF :



$$D_{PAD} = 2(r + 0.61\sqrt{Rt})$$

SINCE THE LOCALIZED BENDING MOMENT WILL DIMINISH OUTSIDE OF REINFORCING PAD, THE REGULAR PORTION OF PIPE IS NOT AFFECTED BY THE LOCALIZED STRESSES.

IT IS CONSERVATIVE TO INCLUDE THE PAD THICKNESS WHEN COMPUTING PIPE LOCAL STRESSES, WHILE SUFFICIENT WELDS ARE EXISTED BETWEEN THE PAD AND PIPE TO AGAINST THE SLIPPAGE BETWEEN THESE TWO COMPONENTS, THE USAGE OF COMPOSITE SECTION IS WARRENTED.

ATTACHMENT I

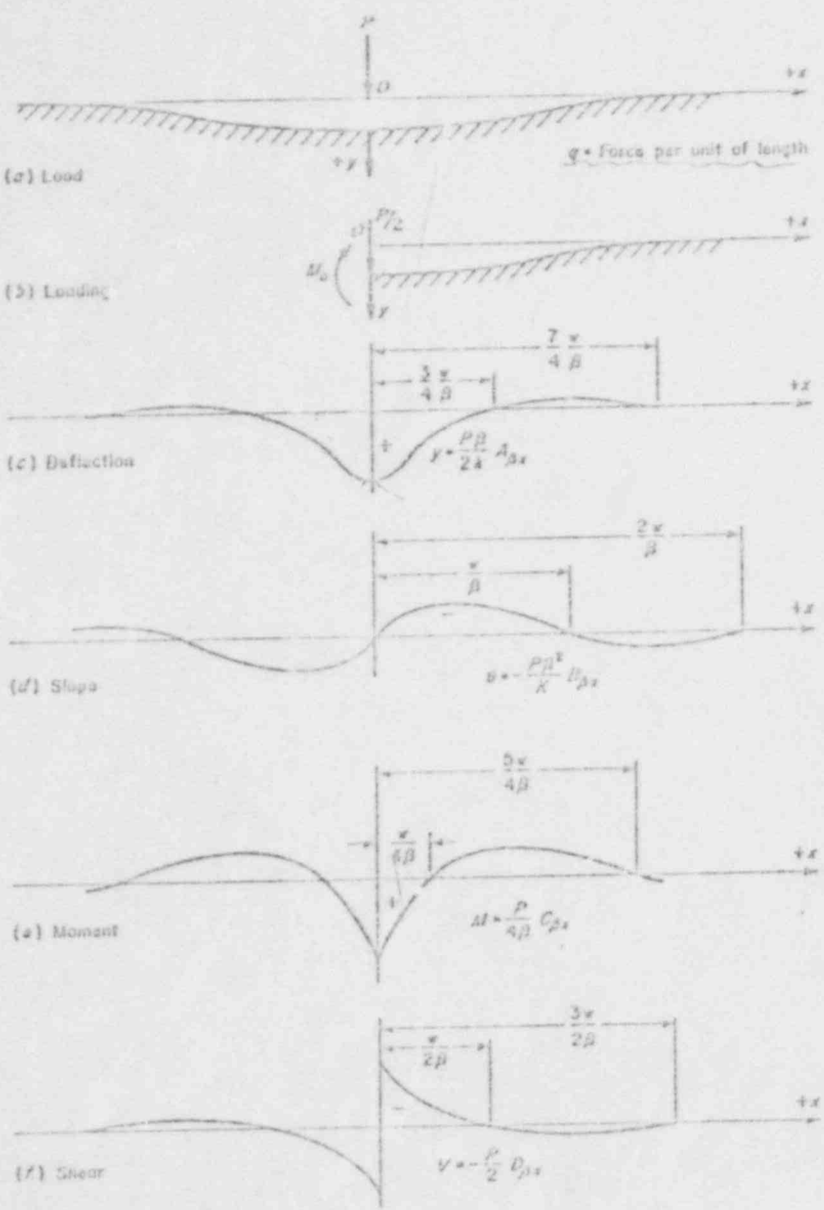
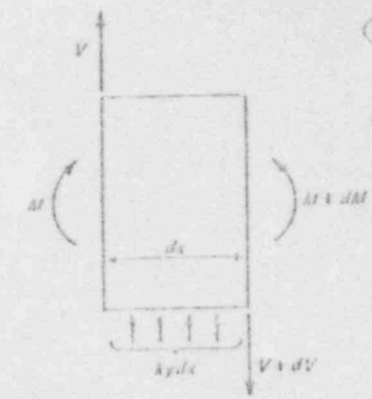


Fig. 4.1. Loading, Deflection, Slope, Moment, and Shear in a Beam on an Elastic Foundation



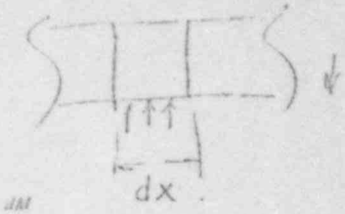


Fig. 4.2. Forces on Foundation Element

or

$$\frac{dV}{dx} = ky \tag{4.2.3}$$

Also, since $V = dM/dx$, its derivatives can be substituted in Eq. 4.2.3 giving

$$\frac{dV}{dx} = \frac{d^2M}{dx^2} = ky \tag{4.2.4}$$

The familiar equation for the elastic curve of a beam in bending is $EI(d^2y/dx^2) = -M$ and differentiating this twice gives

$$EI\frac{d^4y}{dx^4} = -\frac{d^2M}{dx^2} = ky \tag{4.2.5}$$

and substituting the value of d^2M/dx^2 from Eq. 4.2.4 gives the equation for the deflection curve of a beam supported on an elastic foundation,

$$EI\frac{d^4y}{dx^4} = -ky \tag{4.2.6}$$

The general solution of this equation,[2,3] using the notation

$$\beta = \sqrt[4]{\frac{k}{4EI}} \tag{4.2.7}$$

C'

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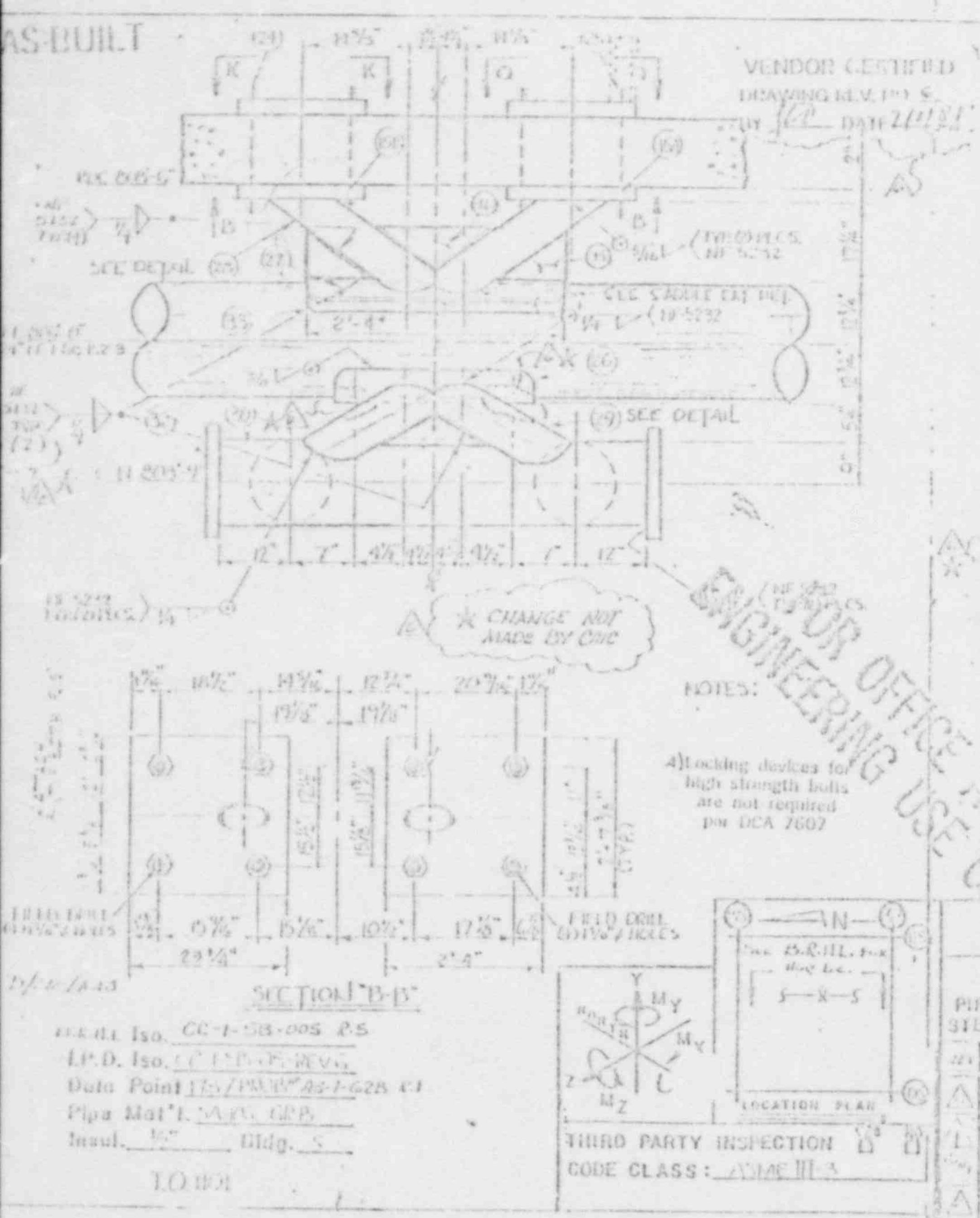

NOTES:

4) Locking devices for high strength bolts are not required per DCA 7607

ITEM NO.	MATERIALS & OPERATIONS	QUAN	SHIP		PBS	L	CSS	PRIM	SEC	AISC
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
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	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] PLATE PER SECTION (SA515/SA516 GR 65)	1			X			X		
	[illegible] THD (SA193 GR B7) ROD									
	[illegible] THD (SA193 GR B7) ROD									
	[illegible] HEAVY HEX NUTS									
26	[illegible] PLATE SEE DETAIL 26	1						X		
27	[illegible] PLATE SEE DETAIL 27	1						X		
28	[illegible] FIELD TRIM AS REQ'D (SA106 GR B) PER DETAIL "28"					X		X		
29	[illegible] PIPE FIELD TRIM AS REQ'D (SA106 GR B) PER DETAIL "29"	2				X		X		
30	[illegible] PIPE x 4'-8" (SA106 GR B)									
31	[illegible] PIPE x 2'-8" FIELD TRIM AS REQ'D (SA106 GR B) PER DETAIL 31	1				X		X		
32	[illegible] (SA515/SA516 GR 65)	2			X			X		
33	[illegible] FIELD TRIM AS REQ'D	2			X			X		
34	[illegible] HEAVY HEX NUTS									
35	[illegible] FIELD CUT TO SUIT	2			X			X		
36	[illegible] FIELD CUT TO SUIT	2								

REV	DATE	DWN	CHK	APP	DESCRIPTION
					REV'D VENDOR CERTIFICATION
					REV'D VENDOR CERT
					REV'D VENDOR CERT
					REV'D VENDOR CERTIFICATION

MARK [illegible]
PAINT: CARBO ZINC 11

MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS
PIPE: [illegible] ELECT: [illegible]
STEEL: [illegible] H.V.A.C.: [illegible]

CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EMERGENCY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FAULTED						

REV	DATE	DWN	CHK	APP	DESCRIPTION
					[illegible]
					[illegible]
					Vendor certification [illegible]
					REV'D VENDOR CERT

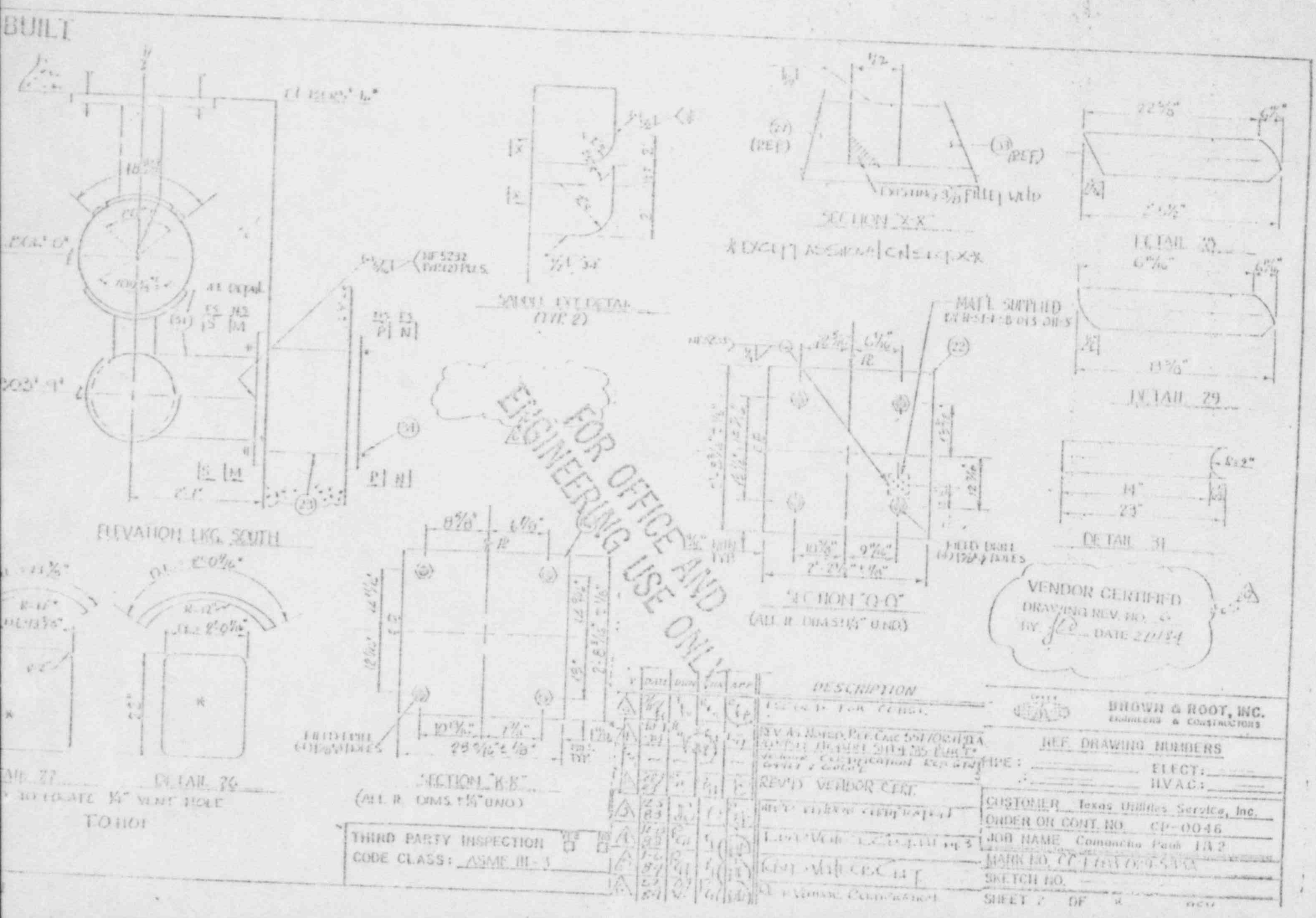
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT. NO. CP-0046
JOB NAME Comanche Peak Unit 2
MARK NO. [illegible]
SKETCH NO.
SHEET 1 OF 3 REV. [illegible]

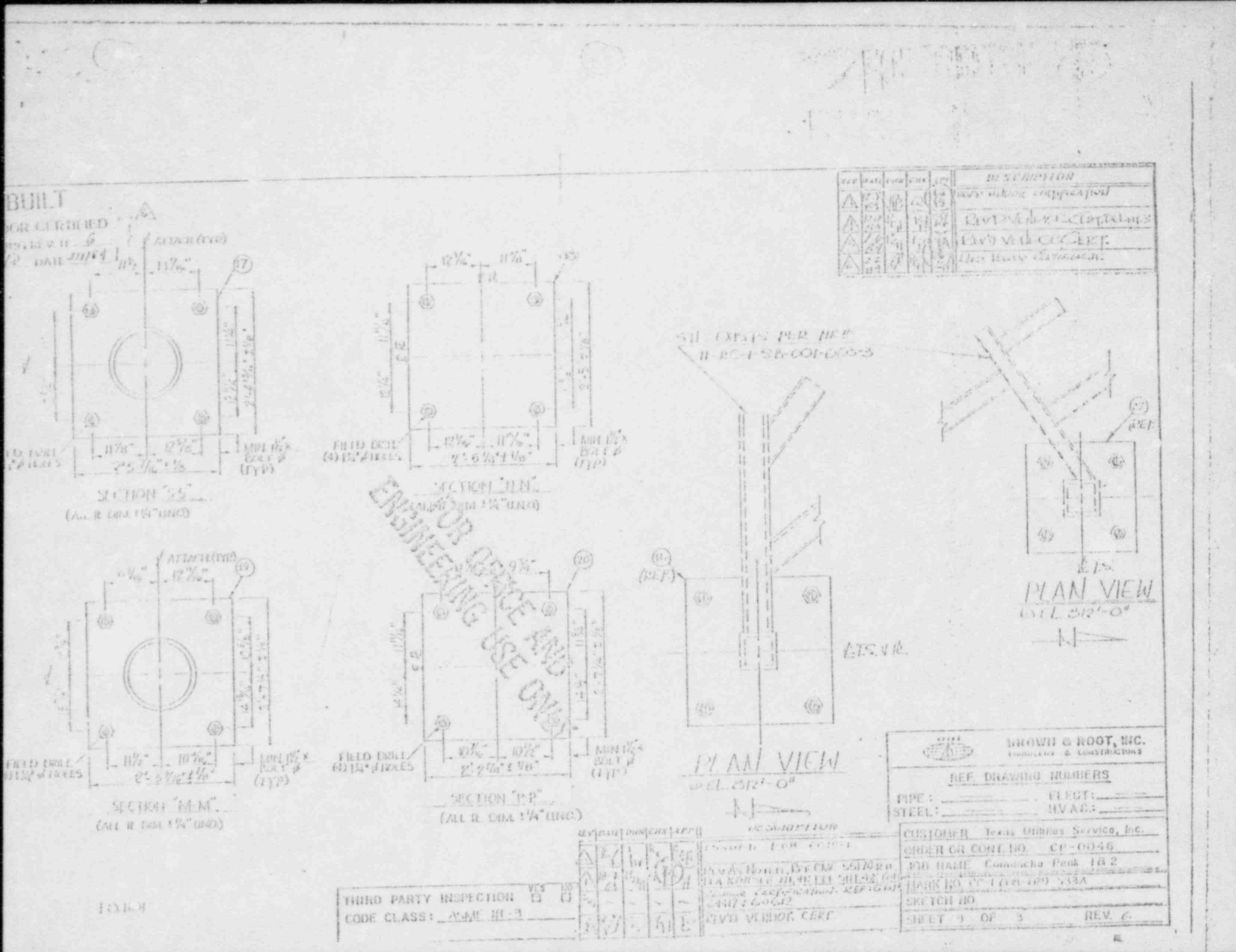
Ref. Iso. CC-1-SB-005 R.5
I.P.D. Iso. [illegible]
Data Point [illegible]
Pipe Mat'l. SA106 GR B
Insul. [illegible] Bldg. S

THIRD PARTY INSPECTION
CODE CLASS: ASME III-3

LOCATION PLAN

Att. C'


BUILT
ELEVATION LKG. SOUTH
DETAIL 27
DETAIL 26
TO HOT
SADDLE EXT DETAIL
(TYP. 2)
SECTION "K-K"
(ALL R DIMS ±1/16" UNO)
SECTION "X-X"
EXISTING 3/16 FILLET WELD
SECTION "Q-Q"
MAT'L SUPPLIED
FIELD DRILL
DETAIL 30
DETAIL 29
DETAIL 31
FOR OFFICE AND ENGINEERING USE ONLY
VENDOR CERTIFIED
DRAWING REV. NO. 6
DATE 2/1/84
THIRD PARTY INSPECTION
CODE CLASS: ASME III-3
DESCRIPTION
ISSUED FOR CONST.
REV'D VENDOR CERT.
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF. DRAWING NUMBERS
ELECT:
H.V.A.C.:
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT. NO. CP-0046
JOB NAME Comanche Peak 1 & 2
MARK NO.
SKETCH NO.
SHEET 2 OF



BUILT
VENDOR CERTIFIED
ATTACH (TYP)
SECTION "S-S"
(ALL R. DIM 1¼" UNO)
SECTION "N-N"
(ALL R. DIM 1¼" UNO)
SECTION "M-M"
(ALL R. DIM 1¼" UNO)
SECTION "P-P"
(ALL R. DIM 1¼" UNO)
FIELD DRILL (4) 1¼" Ø HOLES
MIN 1⅛" x BOLT Ø (TYP)
STL EXISTS PER REF
PLAN VIEW
EL. 812'-0"
(REF)
FOR OFFICE AND ENGINEERING USE ONLY
DESCRIPTION
REV'D VENDOR CERT.
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF. DRAWING NUMBERS
PIPE:
STEEL:
ELECT:
H.V.A.C.:
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT. NO. CP-0046
JOB NAME Comanche Peak 1 & 2
SKETCH NO.
SHEET 3 OF 3
REV. 6
THIRD PARTY INSPECTION YES NO
CODE CLASS: ASME III-3

C'

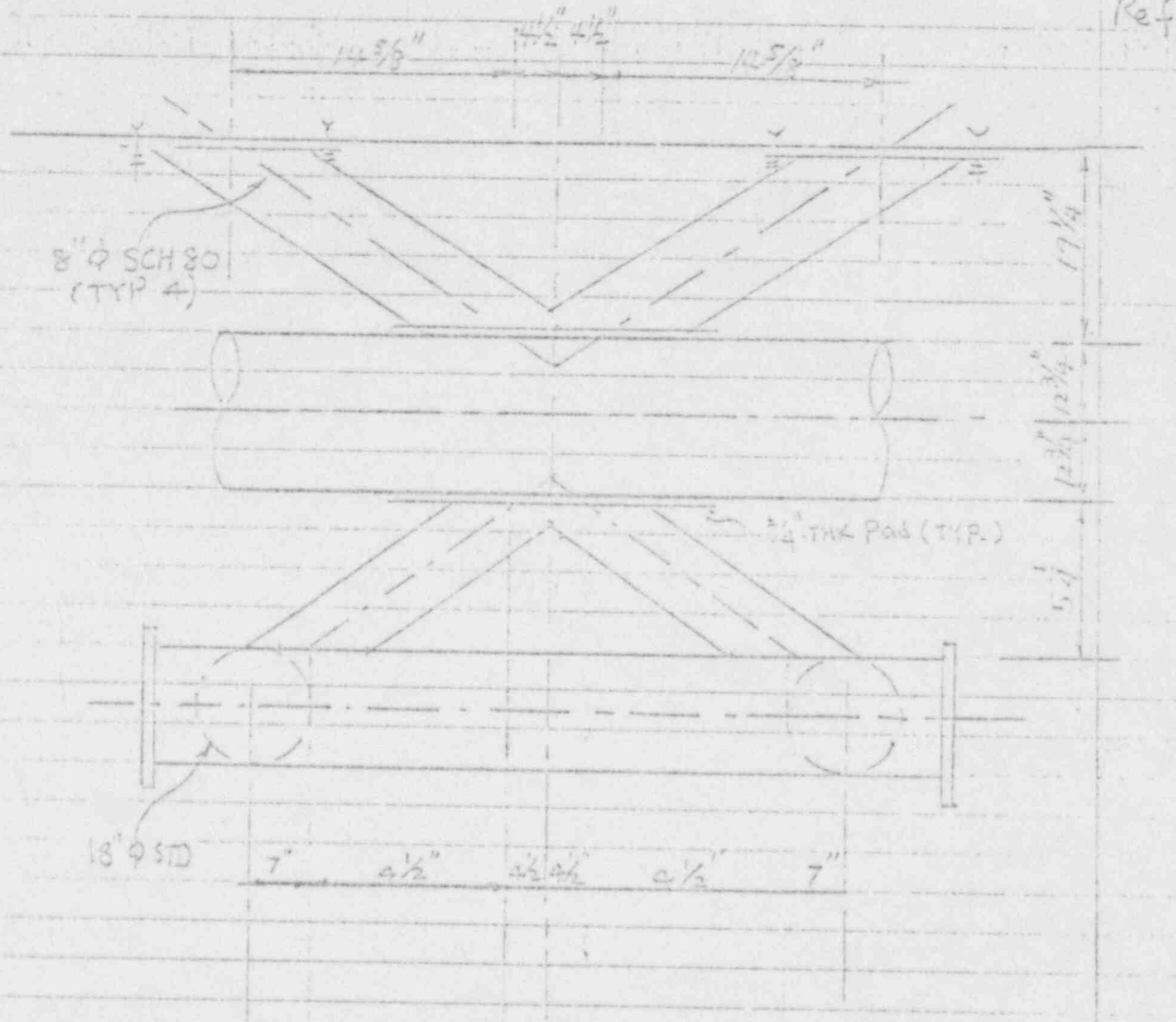
FORM DHE-5

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

Date 9-18-84
Calc By C. Lu
Chk. Apprv. By T. Kuo
Subject CC-1-008-028-S33A

Filing Code
Sheet No. 1 of 12
O & H Job No.
Ref. Dwg.-Spec. No.

Ref



Line No : 24" CC-1-008-152-3
Pipe : 24"φ (STD)
THK : 0.375"
OP. Temp : 189°F
OP. Press : 150 PSI
Mat'l : SA-106 GR B

FORM DHE-5

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

Date 9-18-84
Calc By C L
Chk & Appr. By T. Kuo
Subject CC-1-008-029-S33A P-6

Filing Code
Sheet No. 2 Of 12
G & H Job. No.
Ref. Dwg. Spec. No.

Ref

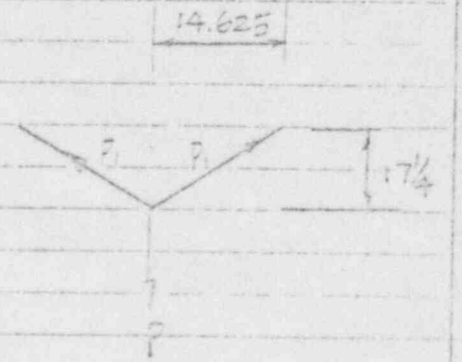
Calculate the support structure stiffness

A) Upper Structure (Item # 28)

To find P_1

$$P_1 = \frac{P}{2} / \sin\left(\tan^{-1}\frac{17.25}{14.625}\right)$$

$$= 0.6555\ P$$



Member Properties 8 φ SCH.80

$A = 12.8\ in^2$ $S = 24.5\ in^3$ $I = 106\ in^4$ $r = 2.88\ in$
$E = 27.7\times10^6$ psi @ 200°F

Use Virtual Work

$$\Delta l = \Sigma \frac{P_i^2\ l_i}{P\ E A_i}$$

$$= \frac{(0.6555\ P)^2 \times (17.25^2 + 14.625^2)^{1/2}}{P \times 27.7\times10^6 \times 12.8} \times 2$$

$$= 5.48\times10^{-8}\ P\ \text{in}$$

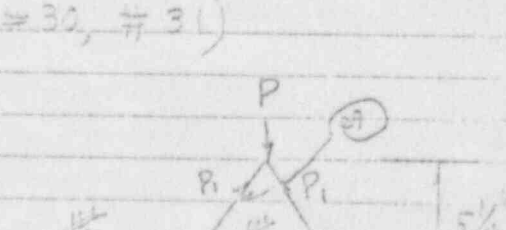
$$\therefore\ K_u = P/\Delta l = 1.82\times10^7\ \text{lb/in}$$

B) Lower Structure (Item # 29, # 30, # 31)

$$P_2 = P/2$$

$$P_1 = P_2 / \sin\left(\tan^{-1}\frac{5.25}{4.5}\right)$$

$$= 0.6585\ P$$



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

FORM DHE-5

Date 9-18-84
Calc By C. Li
Chk'd/Apprd. By T. Kuo
Subject CC-1-008-029-S33A Rev 6

Filing Code

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

Rev 6

a) Virtual work to calculate deflection in lower part of structure

$$\Delta_8 = \sum_i \frac{P_i^2 l_i}{P E A_i}$$

$$= 2 \times \frac{(0.6585 P)^2 (45^2 - 52.5^2)^{1/2}}{P \times 27.7 \times 10^3 \times 12.8}$$

$$= 1.69 \times 10^{-8} P$$

b) 18" ⌀ Pipe from base plate (Assumed as guided cantilever beam)

$$\Delta_{18} = \frac{\frac{P}{2} l^3}{12 E I} + \frac{\frac{P}{2} l}{G A_s} \qquad A_s = \frac{1}{2} A_s = 10.4 \text{ in}^2$$

Shear deformation "Mechanics of Material" By Timoshenko & Gere

$$= \frac{P}{2} \left(\frac{23^3}{12 \times 27.7 \times 10^3 \times 807} + \frac{23}{10.65 \times 10^3 \times 10.4} \right)$$

$$= 1.265 \times 10^{-7} P$$

** Shear deflection of grout-in anchor bolt are not considered since it is conservative.

	Ref
$K_L = P/(\Delta_8 + \Delta_{18} + \Delta_{G1})$	
$= P/P(1.69\times10^{-3} + 1.265\times10^{-7})$	
$= 1/(1.434\times10^{-5}) = 6.974\times10^{6}$ lb/in	

Pipe Stiffness

From ANSY finite element run for this support | data 9.28/84

$P = 14038^{\#}$ $\Delta_4 = 0.175\ 3\text{-}1''$ $K_{LP} = P/\Delta = 8.022\times10^{5}$ #/in at joint 45

$P = 14038^{\#}$ $\Delta_L = 0.175\ 3\text{-}1''$ $K_{LP} = \frac{P}{\Delta} = 8.011\times10^{5}$ #/in at joint 1

Calculate the thermal growth due to thermal expansion

Expansion Coefficient (α) $\times10^{-6}$ in/in-°F — ASME Sec III Subsec NA / PP Table I-5.0

	100°F	146.5°F	150°F	189°F	200°F
SA-106 GR B	5.73	5.897	5.91	6.05	6.09

A) Pipe thermal expansion & pressure dilation

$$\delta_D = \alpha D (T_p - T_o)$$
$$= 6.05\times10^{-6}\times 24 \times (189-70)$$
$$= 1.728\times10^{-2}\ \text{in}$$

$$\delta_{Pr} = \frac{Pr^2}{Et}\left(1-\frac{\mu}{2}\right)$$ — Formula for Stress & Strain by Roark & Young Table 29 Case 1.C.

$$= \frac{150\times12.75^2}{27.7\times10^6\times(.75+.375)}\left(1-\frac{0.3}{2}\right)$$
$$= 6.6512\times10^{-4}\ \text{in}$$

$$\therefore \delta_P = \delta_D + 2\,\delta_{Pr} = 1.861\times10^{-2}\ \text{in}$$

Ref

B) Structure Expansion

Ambient temperature $T_A = 104°F$

$\therefore T_S = \frac{189+104}{2} = 146.5°F$

$T_O = 70°$

$\delta_u = \alpha \cdot l_u \times (T_S - T_O)$
$= 5.897 \times 10^{-6} \times (17.25 + .75) \times (146.5 - 70)$
$= 8.121 \times 10^{-3}$ IN

$\delta_L = \alpha \times l_L \times (T_S - T_O)$
$= 5.897 \times 10^{-6} (5.25 + 9 + 0.75) \times (146.5 - 70)$
$= 6.767 \times 10^{-3}$ IN

c) Concrete Expansion — AISC Sec 6.13

$\alpha = 0.00055/100 = .0000055$ in/in/°F

$\therefore \delta_{con} = .0000055 \times 37 \times (104 - 70)$
$= 1.066 \times 10^{-2}$ IN

The net expansion

$\delta_{net} = \delta_p + \delta_u + \delta_L - \delta_{conc}$
$= 2.284 \times 10^{-2}$ IN

Equivalent Force due to expansion

$\delta_{net} = (\frac{P}{K_u} + \frac{P}{K_{up}}) + (\frac{P}{K_L} + \frac{P}{K_{lP}})$

$2.284 \times 10^{-2} = P[(\frac{1}{1.182 \times 10^7} + \frac{1}{5.412 \times 10^5}) + (\frac{1}{6.974 \times 10^6} + \frac{1}{8.011 \times 10^5})]$

$P = 8481$ lbs

TEXAS UTILITIES SERVICES INC.
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TEXAS POWER & LIGHT COMPANY

Date 9-28-84
Calc By C. Lee
Chk & Apprd. By T. Kuo
Subject CC-1-008-009-S33A. R-6

Filing Code

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

Ref: ANSYS Run 9-28-84

pipe local stress

From finite element analysis (ANSYS Result) the max. stress occurred at element 47 (it is inner pad reinforcing zone).

the principle stress is

$\sigma'_{pl} = 17918$ psi. (@ P = 14038#)

The actual stress (ratio down as $\frac{8481}{14038}$) at P_{ac} = 8484 lbs

$$\sigma_{pl} = \sigma'_{pl} \times \frac{8481}{14038}$$

$$= 17918 \times \frac{8481}{14038} = 10825 \text{ PSI}.$$

From G&H calc. 1-67B & 1-67A sheet 64

eq 11 σ_1 = pipe stress + anchor load local stresses = 25224 psi.

The overall stress

$$\sigma_{all} = \sigma_1 + \sigma_{pl} = 25224 + 10825$$

$$= 36049 \text{ psi} < S_A + S_h = 37500 \text{ psi}$$

Therefore pipe local stress is acceptable.

FORM DHE-5

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

Date 9-28-84
Calc By C Lu
Chk'd/Appr'd By T Kuo
Subject CC-1-008-029-S33A R-6
Ref. Dwg. Spec. No.

Filing Code
Sheet No. 7 of 12
G & H Job. No.

Ref.

<u>Check member stress</u>

Highest stress member are member #1 & #7

(item #31) 18" Φ Pipe STD ($P = \frac{8481}{2} = 4241$ #)

$A = 20.8\ in^2 \quad I = 807\ in^4 \quad S = 89.6\ in^3$

$f_b' = \frac{M}{S} = \frac{\frac{1}{2} \times 4241 \times 23}{89.6} = 544.3\ psi$

Existing bending stress is 2925 psi. — Existing As-built Calculation

$\therefore f = 2925 + 544.3 = 3469.3\ psi$
$< 19150\ psi\ (= 0.6 \times 31.9^{ksi})$

SA-106 GR B

For Shear stress (circular section)

$f_v' = \frac{f_y}{A/2} = \frac{4241}{20.8/2} = 408\ psi$

Thus, with existing shear of 1116 psi — Existing As-built calculation

$f_{vT} = 1116 + 408 = 1524\ psi < 12760\ psi$
$(= 0.4 \times 31900)$

OK

Therefore member is OK

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TEXAS POWER & LIGHT COMPANY

FORM DHE-5

Date 9-28-84
Calc By C. Lu
Chk'd & Apprd. By Y. Kuo
Subject CC-1-032-029-S33A R-6

Filing Code

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

Ref

Check welds

Most of welds will experience compression load
The only weld should be looked at is item 31 to base plate. Since it is a conservative design
(f_R = 1243 lb/IN VS. F_{ALL} = 3027 lb/in) Therefore weld is ok.

[illegible] Forces to Base Pl. [illegible]

A) Upper base plate will experience compression load
Therefore, there is no affect to the bolt & plate

B) The lower base plate assy
Since the diagonal [illegible] a [illegible] therefore horizontal force is ignored
(Should be very small)

For each base plate, force are

$F_y = P/2 = \frac{8481}{2} = 4240.5$ lb

$M_x = F_y \cdot l/2 = 4240.5 \times 23/2 = 48766$ IN-lb

Check the most critical plate Sec M-M

PSDI base plate analysis was based on F_y = 6052 lb, M_x = 139196 in-lb
Since M_x is larger, this is conservative. Based on F_y = 6052 lb
M_x = 139196 in-lb the PSDI input data was calculated as follows:

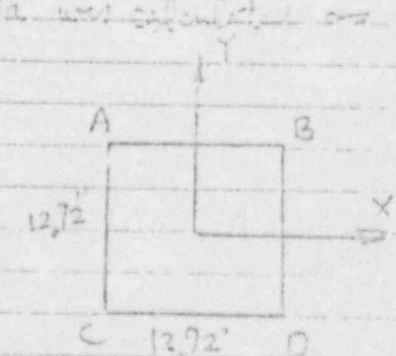
Base Plate Model see Existing As built Calculation SHT 16-24

A = $M_x/(2 \times 12.72) = 5472$ lb

B = $M_x/(2 \times 12.72) = 5472$ lb

C = $-M_x/(2 \times 12.72) = -5472$ lb

D = $-M_x/(2 \times 12.72) = -5472$ lb



Thus it is conservative to use the computer output of this PSD I base plate analysis and combine with the existing stress to analyze the bolt and plate. — Ref/6

$f_t = 3383^{lb}$

$f_v = 1547^{lb}$ $\sigma_{pl} = 1703$ psi — See SHT 11

Existing force on bolt and stress on plate are — Existing as-built calculation base plate analysis

$f_{t_1} = 10733^{lb}$ $f_v = 2758^{lb}$ $\sigma_{pl} = 5047$ psi

$\therefore f_{t\ total} = 10733 + 3383 = 14116^{lb}$

$f_{v\ total} = 2758 + 1547 = 4305^{lb}$

Since grouted thru bolt; wall thickness is more than 2'-0" Design tension based on bolt capacity only

$1\frac{1}{8}"\phi$ $A_{TENSION} = \underline{0.763}\ in^2$

Interaction as — P.S.E guideline Sec VI 3.1.1

$$\left(\frac{f_t}{F_t}\right) + \left(\frac{f_v}{F_v}\right) \leq A = .763\ in^2$$

$$\frac{14116}{75000} + \frac{4305}{49000} = .276 < .763 \quad \text{O.K.}$$

For the base plate

$\sigma_{pl} = 5047 + 1703 = 6750$ psi < 26100 psi

OK

B1284

X-418.

DHE-41
REV. 0

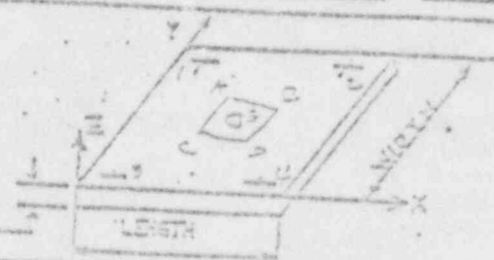
BASE PLATE ANALYSIS INPUT SHEET

SH'T. [illegible]
10 of 12

INPUT BY C. LU DATE 4.30.86 CHECKED BY T. KUO DATE [illegible]

ENTER TITLE
REF. NO. CC-1-009-029-S33A. R-6 NPSI NO. ______
CH. ______ REV. ______ CH. ______ REV. ______
CH. ______ REV. ______ CH. ______ REV. ______

SEC. M-M
(EXPANSION LOAD ONLY)



BOLT LOCATION
LOAD LOCATION

THICKNESS 2"

ENTER LENGTH, WIDTH, AND THICKNESS OF BASE PLATE		
LENGTH (IN.)	WIDTH (IN.)	THICKNESS (IN.)
29.1875	31.5	2

HOW MANY BOLTS ARE THERE IN THE BASE PLATE? NO. OF BOLTS= 4

FOR EACH BOLT ENTER THE X-LOCATION; Y-LOCATION; DIAMETER AND LENGTH (OR STIFFNESS)

BOLT LOC	X-LOCATION (IN.)	Y-LOCATION (IN.)	DIAMETER (IN.)	STIFFNESS (LBS./IN.)	PRELOAD (LBS.)
1	5.5	28.375	1.125		
2	27.375	28.6875	1.125	500,000	0
3	3.0625	2	1.125		
4	25.4375	3.0625	1.125		

(DIMENSION FOLLOWS THE EXISTING CALC. IT'S APPROVED ± 1/4 DEVIATIONS O.K.)

HOW MANY LOAD POINTS ARE THERE IN THE PLATE? NO. OF LOAD POINTS= 5

FOR EACH LOAD POINT THE X-LOCATION; Y-LOCATION; Fx; Fy; Fz; Mx; My; Mz

CASE	LOAD PT.	X-LOC. (IN.)	Y-LOC. (IN.)	Fx (LBS.)	Fy (LBS.)	Fz (LBS.)	Mx (IN-LBS.)	My (IN-LBS.)	Mz (IN-LBS.)
	A	8.3275	24.235						
	B	21.6475	24.235			5472			
	C	8.3275	11.515			5472			
	D	21.6475	11.515			-5472			
	E	16.6375	17.875			-547[illegible]			
					6052				

*** BRIDGE VERS *** [illegible] REV.6 (SECT X-X)   [illegible] *** 04/30/84 PAGE 007

checked by TK ... 5/6/84

SHT 11 of 12

****
* RESULTS OF [illegible] ANALYSIS *
****

JOB ID - [illegible]   JOB TITLE - [illegible] REV.6 (SECT X-X)

ACTIVE UNITS - LENGTH INCH   WEIGHT [illegible]   ANGLE [illegible]   TEMPERATURE [illegible]   TIME SEC   [illegible]

[illegible] RESULTS SUMMARY LEVEL 1

SPECIFIED GENERAL DATA

PLATE DIMENSION IN X DIRECTION....... 29.187
PLATE DIMENSION IN Y DIRECTION....... 31.500
PLATE THICKNESS........................ 2.000
PLATE MODULUS.......................... 0.277000E 08
[illegible]............................ 0.[illegible]000E 07
PLATE ELEMENT TYPE..................... [illegible] [illegible]

SPECIFIED BOLT/PIN DATA

NUMBER OF [illegible]................... 4

//--[illegible]--/	X	Y	Z	/-BOLT/PIN-/	KF AXIAL	/-DIAMETER-//
[illegible]	3.0625	2.0000	0.0	3	[illegible]0000.000	1.125
[illegible]	5.5000	28.1750	0.0	1	500000.000	1.125
[illegible]	25.4375	3.[illegible]	0.0	4	500000.000	1.125
[illegible]	27.3750	28.4375	0.0	2	500000.000	1.125

LOADING 1   [illegible]

[illegible] LOAD VALUES AND THEIR LOCATIONS

SHT

*** [illegible] *** CC-1 [illegible] REV.C [illegible] 15:10:45.41 *** 04/30/84 PAGE [illegible] ***

Checked by TK

NUMBER OF LOAD POINTS.................. 5

NODE	LOCATION X	LOCATION Y	LOCATION Z	FORCES X	FORCES Y	FORCES Z	MOMENTS X	MOMENTS Y	MOMENTS Z
	8.3275	24.2384	0.0	0.0	0.0	-5472.000	0.0	0.0	0.0
	21.0475	24.2350	0.0	0.0	0.0	-5472.000	0.0	0.0	0.0
	8.3275	11.5150	0.0	0.0	0.0	-5472.000	0.0	0.0	0.0
	21.0475	11.5150	0.0	0.0	0.0	-5472.000	0.0	0.0	0.0
	14.6575	17.8750	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0

COMPUTED BOLT/PIN LOADS

NODE	LOCATION X	LOCATION Y	LOCATION Z	BOLT/PIN	AXIAL FORCE	SHEAR FORCES GLOBAL-X	SHEAR FORCES GLOBAL-Y	SHEAR FORCES SRSS
20201	3.0625	2.0000	0.0	3	0.0	-45.876	1554.634	1555.311
30101	5.5000	31.2750	0.0	1	3283.652	45.56[illegible]	1566.387	1567.000
60201	25.4375	3.0625	0.0	4	0.0	-42.2[illegible]	1478.764	1479.3[illegible]
[illegible]	27.3750	28.1875	0.0	2	2576.608	44.1[illegible]	1472.153	1472.[illegible]

COMPUTED DISPLACEMENTS/ROTATIONS AT LOAD POINTS

NODE	LOCATION X	LOCATION Y	LOCATION Z	DISPLACEMENTS X	DISPLACEMENTS Y	DISPLACEMENTS Z	ROTATIONS X	ROTATIONS Y	ROTATIONS Z
	8.3275	[illegible]	0.0	0.0	0.0	0.000142	0.000358	-0.000152	0.0
	21.0475	[illegible]	0.0	0.0	0.0	0.000[illegible]	0.000421	0.000[illegible]	0.0
	8.3275	[illegible]	0.0	0.0	0.0	0.000[illegible]	0.000[illegible]	[illegible]	0.0
	21.0475	[illegible]	0.0	0.0	0.0	0.000[illegible]	0.000215	0.000[illegible]	0.0
	14.6375	17.8750	0.0	0.0	0.0	[illegible]	0.000[illegible]	[illegible]	0.0

COMPUTED MAXIMUM PRINCIPAL STRESS VALUES

MAXIMUM PRINCIPAL STRESS : 1703.11255
[illegible]

SHT 12 of 12

IMAGE EVALUATION TEST TARGET (MT-3)

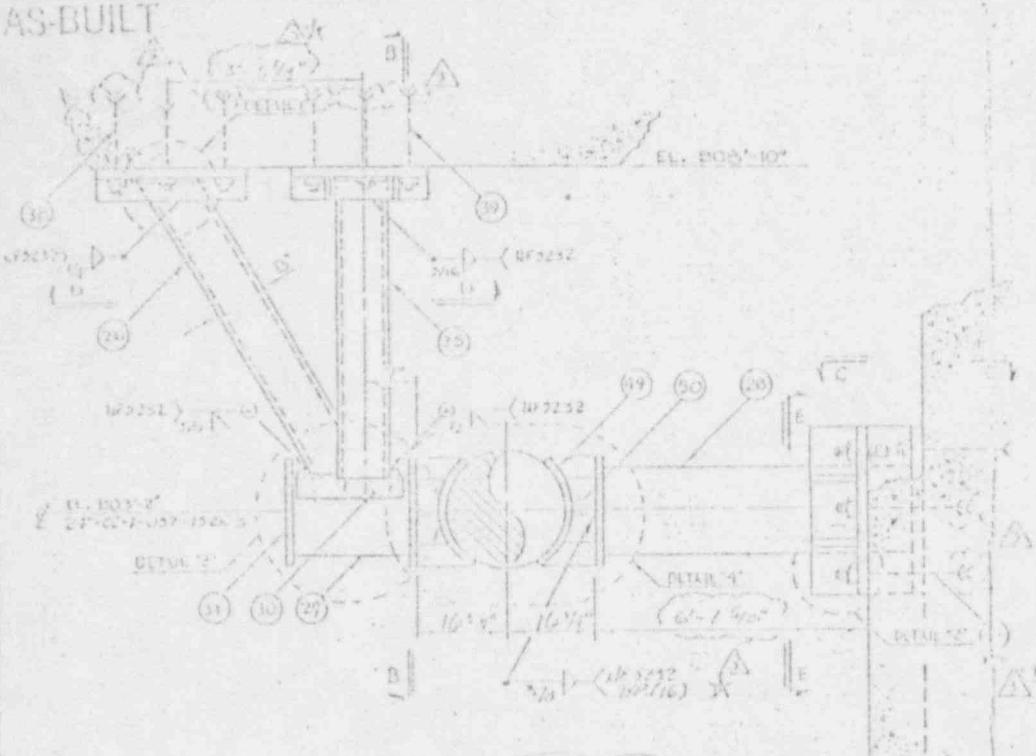
150mm

6"

FOR OFFICE [illegible]

D'

AS-BUILT



ITEM NO.	MATERIALS & OPERATIONS	QUAN	SHIP
	[illegible]		

	DESCRIPTION
△	REV. VENDOR CERT., REF CMC 92332

MARK CC-1-057-021-433A

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

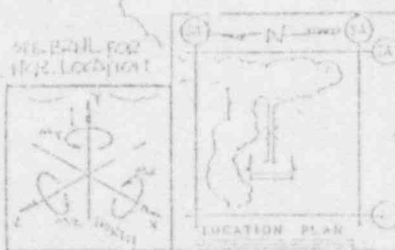
NOTES

1) Locking devices for high strength bolts are not required per DCA 7607

VENDOR CERTIFIED
DRAWING REV. NO. 3
BY [illegible] DATE [illegible]

SEE B&HL FOR HGR. LOCATION

ISO. CC1-AP-12 REV. 6
T.P.B. ISO. CC1-AP-12 REV. 9
Data Point [illegible]
Pipe Mat'l SA-106 GR. B
Insul. [illegible] Bldg. [illegible]



THIRD PARTY INSPECTION YES ☐ NO ☐
CODE CLASS: ASME III-3

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS
PIPE: [illegible] ELECT: [illegible]
STEEL: [illegible] HVAC: [illegible]

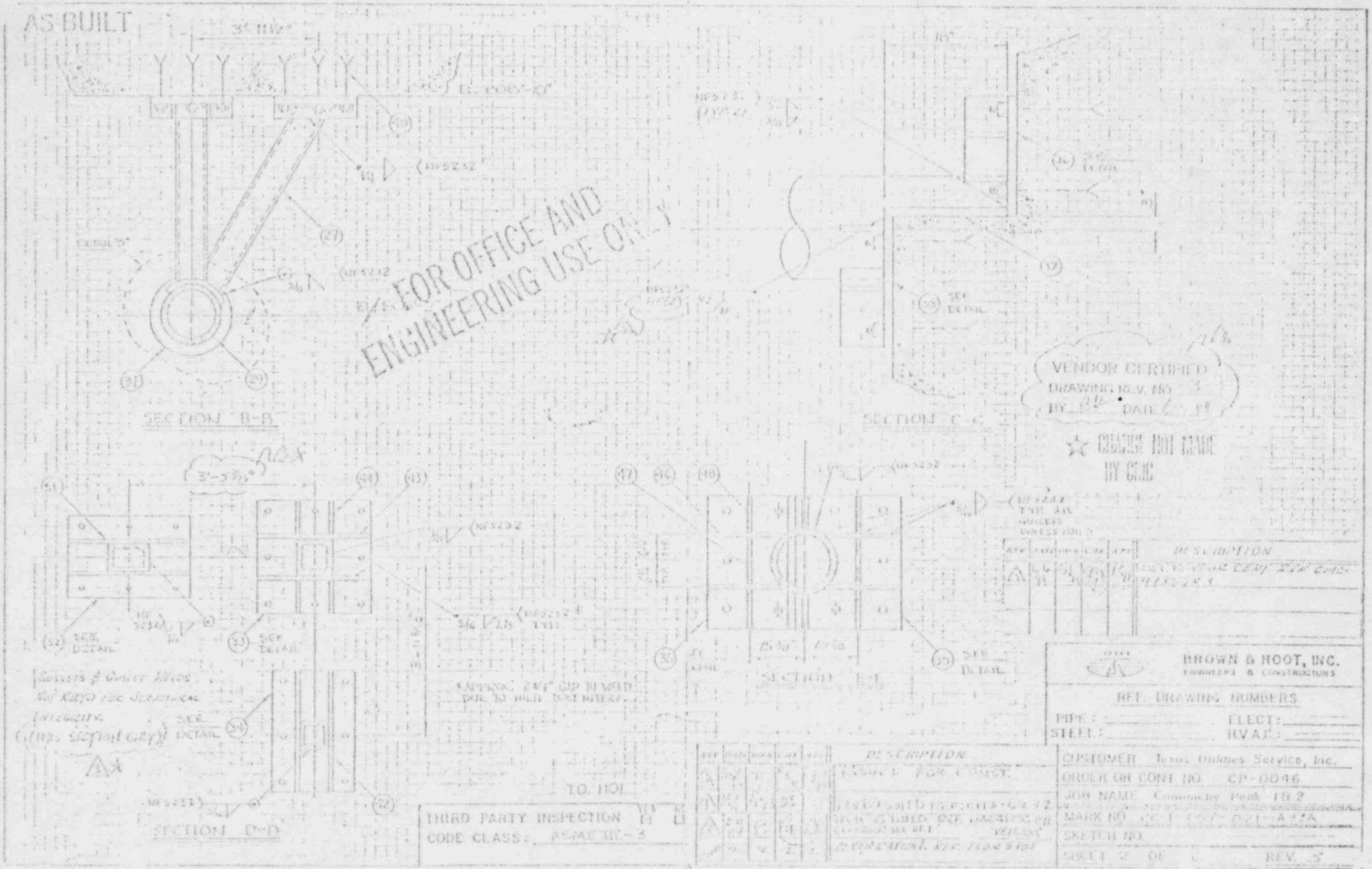
CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET						
EMERGENCY						
FAULTED						

	DESCRIPTION
△	[illegible]
△	[illegible]
△	[illegible] VENDOR
△	[illegible]

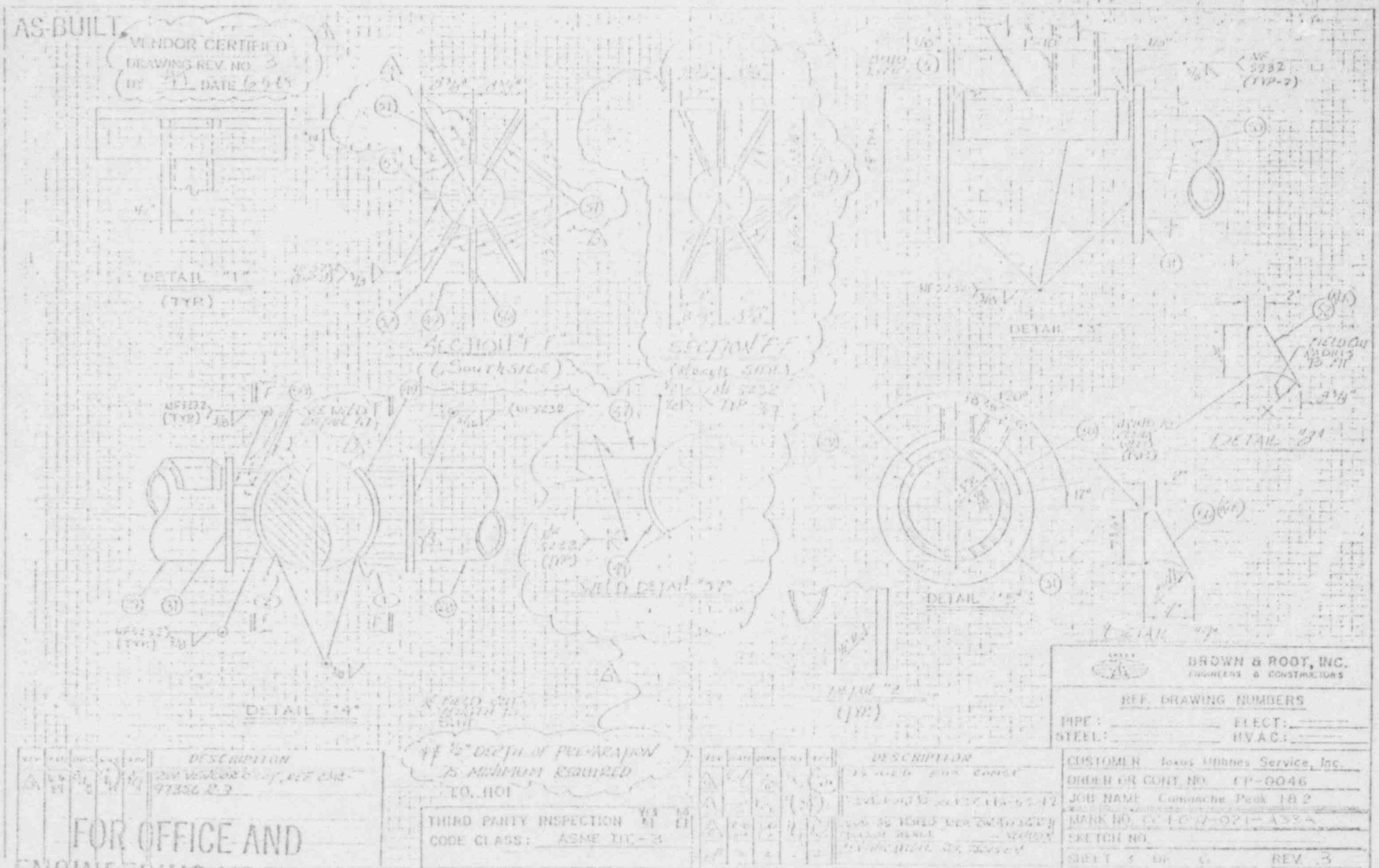
CUSTOMER Texas Utilities Services, Inc.
ORDER OR CONT. NO. [illegible]
JOB NAME Comanche Peak 1 & 2
MARK NO. CC-1-057-021-433A
SKETCH NO.
SHEET 1 OF [illegible] REV. 5

FOR OFFICE AND TRADE
ENGINEERING USE ONLY

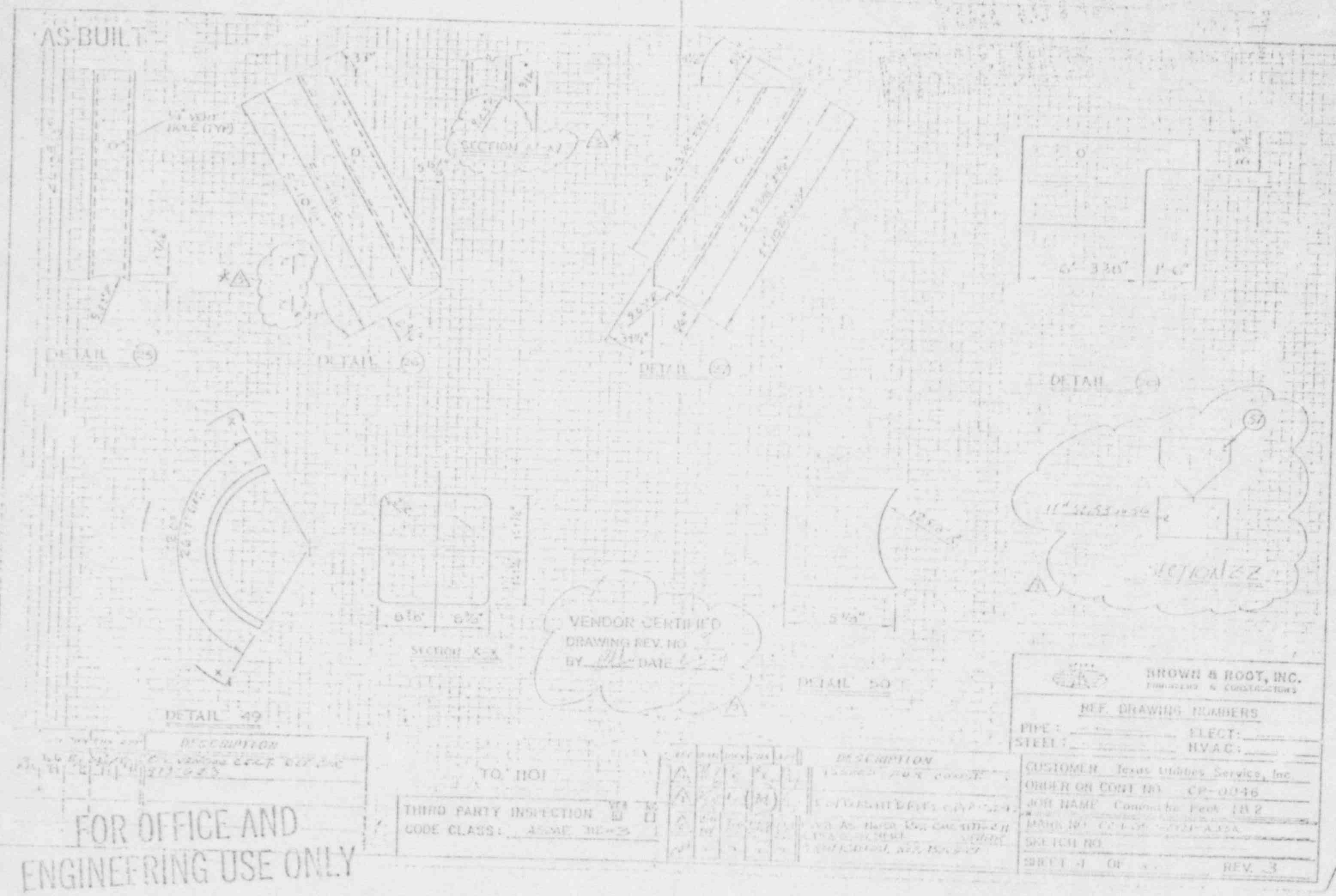
AH. D'

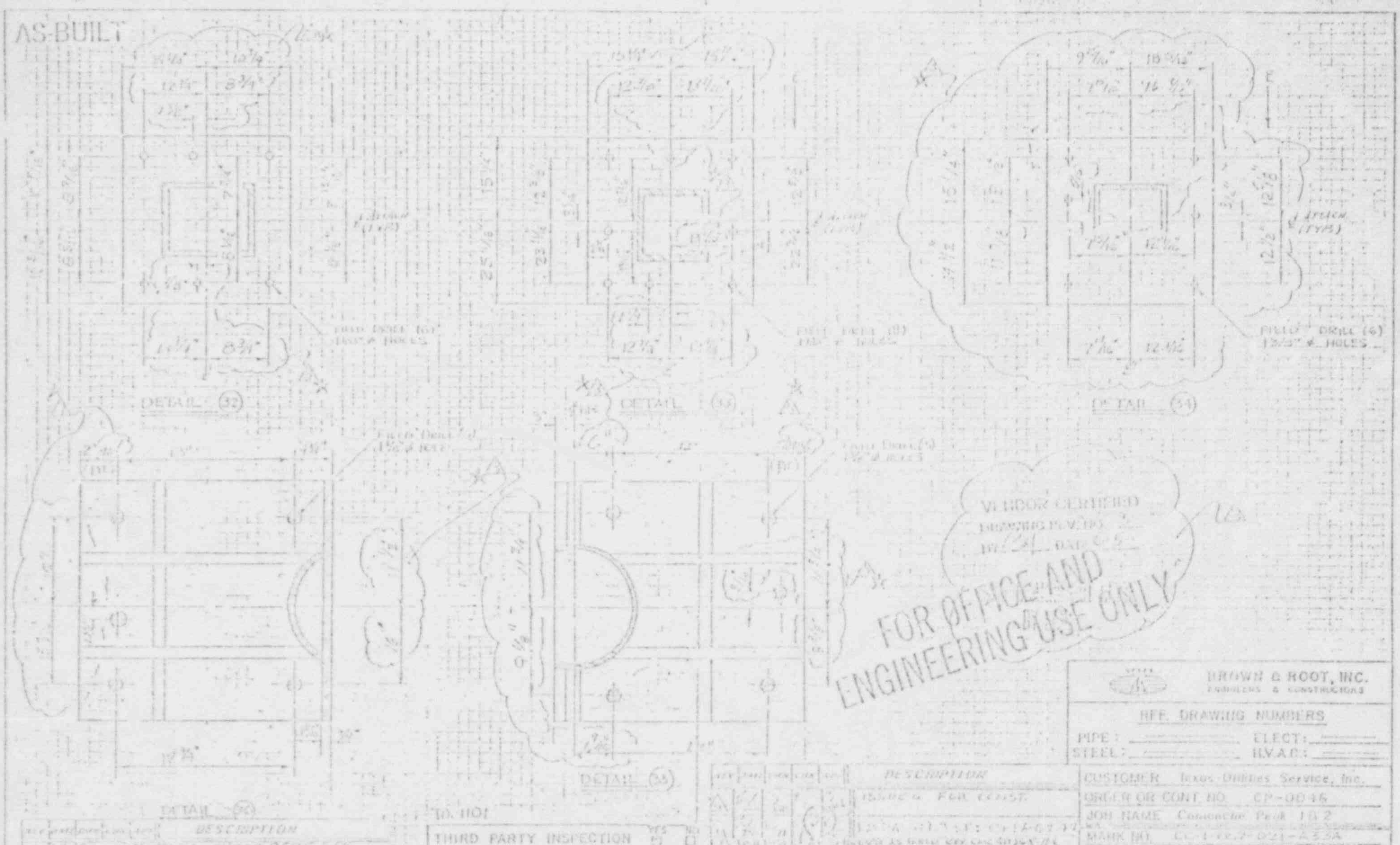


AS BUILT
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
FOR OFFICE AND ENGINEERING USE ONLY
VENDOR CERTIFIED
DRAWING REV. NO. 3
CHANGE NOT MADE BY CBIC
SEE DETAIL
TO. HOL
THIRD PARTY INSPECTION
CODE CLASS: ASME III-3
DESCRIPTION
ISSUED FOR CONST.
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF. DRAWING NUMBERS
PIPE:
STEEL:
ELECT:
HVAC:
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT NO. CP-0046
JOB NAME Comanche Peak FB 2
SKETCH NO.
REV. 3



FOR OFFICE AND
ENGINEERING USE ONLY


AS-BUILT
DETAIL 25
DETAIL 26
DETAIL 28
DETAIL 29
SECTION A-A
DETAIL 49
SECTION X-X
VENDOR CERTIFIED
DRAWING REV. NO
BY DATE
DETAIL 50
TO: 1101
THIRD PARTY INSPECTION
CODE CLASS: ASME III-3
DESCRIPTION
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF. DRAWING NUMBERS
PIPE:
STEEL:
ELECT:
H.V.A.C.:
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT NO. CP-0046
JOB NAME Comanche Peak 1&2
MARK NO.
SKETCH NO.
SHEET 4 OF
REV. 3
FOR OFFICE AND
ENGINEERING USE ONLY


AS-BUILT
DETAIL 32
DETAIL 33
DETAIL 34
DETAIL 35
FIELD DRILL (6) 13/16" ⌀ HOLES
VENDOR CERTIFIED
FOR OFFICE AND ENGINEERING USE ONLY
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF. DRAWING NUMBERS
PIPE:
ELECT:
STEEL:
H.V.A.C.:
CUSTOMER Texas Utilities Service, Inc.
ORDER OR CONT. NO. CP-0046
JOB NAME Comanche Peak 1 & 2
MARK NO.
SKETCH NO.
REV.
DESCRIPTION
ISSUED FOR CONST.
THIRD PARTY INSPECTION
CODE CLASS: ASME III-3

VENDOR CERTIFIED
DRAWING REV. NO. 3
BY [illegible] DATE 6-5-84

CASE ONE

	Fx (LBS)	Fy (LBS)	Fz (LBS)	Mx (IN-LBS)	My (IN-LBS)	Mz (IN-LBS)
NORMAL(A)	+2955	-1832	+6022	-32040	+276312	-187068
	+2955	-1832	+6022	-32040	+275310	-187068
UPSET(B)	+415	-2599	+5534	-90576	+176530	-230774
	+5995	-365	+7410	+25436	+176104	-173412
EMERGENCY(C)	+2[illegible]	-2400	+1483	-409852	+1615[illegible]	-230733
	+5681	+36	+7621	+44723	+390744	-135590
FAULTED(D)	—	—	—	—	—	—

CASE TWO

	Fx (LBS)	Fy (LBS)	Fz (LBS)	Mx (IN-LBS)	My (IN-LBS)	Mz (IN-LBS)
NORMAL(A)	-3310	-6572	-2077	+250008	-256757	+54276
	-3310	-6572	-2077	+250089	-256756	+54276
UPSET(B)	-5850	-7731	-3585	+182732	-303598	+7420
	-770	-5405	-609	+309684	-153154	+12113
EMERGENCY(C)	-6036	-2040	-3676	+179316	-333188	+2556
	-584	-1107	-774	+310030	-144714	+105916
FAULTED(D)	—	—	—	—	—	—

CASE THREE

	Fx (LBS)	Fy (LBS)	Fz (LBS)	Mx (IN-LBS)	My (IN-LBS)	Mz (IN-LBS)
NORMAL(A)	+6127	+713	+5507	-136164	+1957[illegible]	-264516
	+6127	+719	+5597	-136164	+1945[illegible]	-264576
UPSET(B)	+3587	-324	+2831	-194640	+323574	-308172
	+8652	+1761	+5075	-176633	+325103	-220850
EMERGENCY(C)	+1401	-670	+2805	-313176	+153104	-315936
	+8024	+2766	+6006	-23152	+221268	213716

CASE FOUR

	Fx (LBS)	Fy (LBS)	Fz (LBS)	Mx (IN-LBS)	My (IN-LBS)	Mz (IN-LBS)
NORMAL(A)	-307	-4141	+57	+123184	-20512	-2051[illegible]
	-307	-4141	+57	+133794	-20512	-2044[illegible]
UPSET(B)	-2747	-5316	+1411	+14[illegible]3	-150104	-18510
	+2334	-2161	+1595	+101[illegible]0	[illegible]	-5849
EMERGENCY(C)	-7133	-2547	-1512	+4[illegible]282	-135024	-60[illegible]264
	+1579	-2531	+1656	+3[illegible]	+3[illegible]094	+1176
FAULTED(D)	—	—	—	—	—	—

FOR OFFICE AND ENGINEERING USE ONLY

TO 41101

REV	DATE				DESCRIPTION
A					REV VENDOR CERT, REF [illegible]

REV					DESCRIPTION
A					[illegible]
A					[illegible]
3					[illegible]

AUTHORIZED NUCL. INSP. YES [X] NO [ ]
ASME CODE CLASS ASME III-(3)

Brown & Root, Inc.
HOUSTON, TEXAS

CLIENT T.U.S.I.
PLANT COMANCHE PEAK
JOB NO. 2323

SUPPORT NO. [illegible]-A33A
SHEET 6 OF 6 REV. 3

D'

FORM DHE-5

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

Date 9-14-84
Calc By C Lu
Chk'd By T. Kuo
Subject CC-1-057-221-A33A

Filing Code
Sheet No. 1 of 4
G & H Job No.
Ref Dwg Spec No.

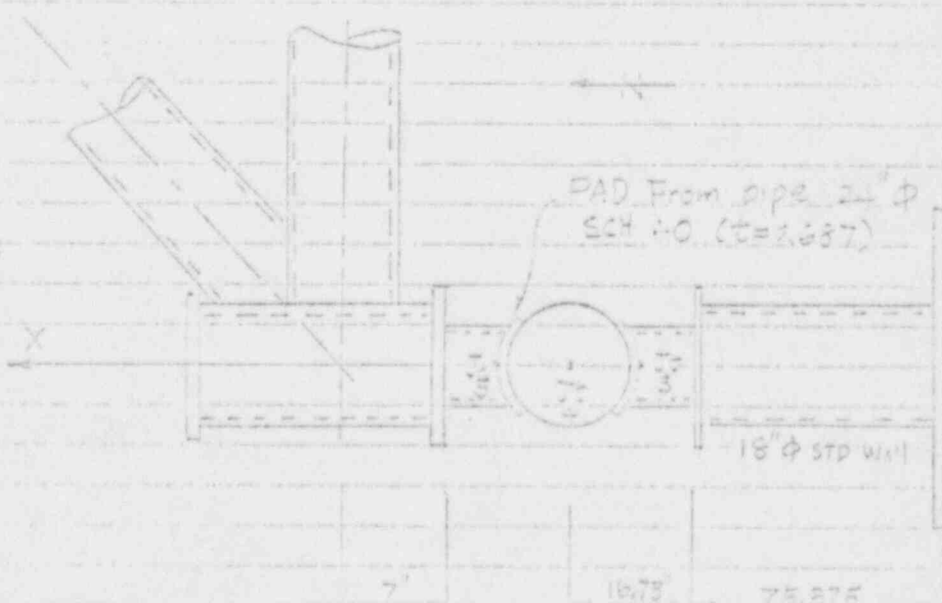
	Ref
Pipe Data	
Size of pipe : 24" Φ	
Mat'l : SA-106 GR B	
THK : STD ($t = 0.375"$)	ME-261
TEMP. OP. : 130°F (225°F)	
Pressure OP. : 132 psi (150 psi)	

Thermal expansion coefficient $\alpha = 5.838 \times 10^{-6}$ in/in/°F @ 130°F

From existing as-built calculation
(STRUDL Run, PS02 strudl data Jan 19, 1984)

To calculate south side and north side stiffness

From case 1 run
Loading 1 input $F_x = 7785^{lb}$ *



* Pipe is assumed to be rigid

FORM DHE-5

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

Date: 9-10-84
Calc By: C. Lu
Chk & Apprd By: T. B.L.O
Subject: CC-1-057-021-A33A
Ref Dwg Spec No:

Filing Code:
Sheet No. 2 of 6
G & H Job No:

From strudl output, the axial force at Jt 3 & Jt 5 due to $F_x = 7795^{lb}$ are

$F_x = 6676.02^{lb}$ at Joint 3

$F_x = 1118.98^{lb}$ at Joint 5

$F_{x\ at\ Jt\ 3} = K_s \Delta_{Jt3}$

$F_{x\ at\ Jt\ 5} = K_N \Delta_{Jt5}$

Since $\Delta_{Jt3} = \Delta_{Jt5}$

$\therefore K_N = \dfrac{F_{x\ at\ Jt5}}{F_{x\ at\ Jt3}} K_s = \dfrac{1118.98}{6676.02} K_s = .1676\ K_s$

Thus stiffness of the North structure can be calculated once south structure's stiffness is calculated

$L_1 = 6.75 - {}^{24}/_2 - .687 = 4.063"$ $A_1 = 16.05\ in^2$ 14"φ STD

$L_2 = 75.375"$ $A_2 = 20.76\ in^2$ 18"φ STD

The deflection of pipe pad is negligible
The thickness of the plate between 14"φ & 18"φ pipe is negligible compared to length of 18"φ pipe (75.375")

$K_1 = \dfrac{A_1 E}{L_1} = \dfrac{16.05 \times 27.7 \times 10^6}{4.063} = .1094 \times 10^9\ {}^{lb}/_{in}$

$K_2 = \dfrac{A_2 E}{L_2} = \dfrac{20.76 \times 27.7 \times 10^6}{75.375} = 7.629 \times 10^6\ {}^{lb}/_{in}$

$\therefore K_s = \dfrac{1}{{}^1/_{K_1} + {}^1/_{K_2}} = 7.132 \times 10^6\ {}^{lb}/_{in}$

@ NORTH STRUCTURE CONSIDER SHEAR SLIPPAGE OF HILTI-BOLT
20 - 1"φ HILTI BOLT (REF. SHT 13A ATTACHMENT)
$K_{HB} = 250 \times 10^3\ {}^{\#}/_{in} \times 20 = 5.0 \times 10^6\ {}^{\#}/_{in}$

$\therefore K_N = \{1/[(.1676 \times 7.132 \times 10^6)^{-1} + (5.0 \times 10^6)^{-1}]\} = 9.647 \times 10^5\ {}^{\#}/_{in}$

FORM DHE-5

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

Date 9-14-86
Calc By C.L.
Chk'd Apprd By T. KUO
Subject CC-1-257-02 -433A

Filing Code ______
Sheet No. 3 of 14
G & K Job No. ______
Ref. Dwg. Spec. No. ______

2) Pipe Stiffness

There is no simple formula for displacement's calculation for cylindrical shell under partial load/case. The pipe is assumed to be rigid for conservatism

3) Pipe Thermal expansion, & dilation due to pressure

$$\delta_R = R \cdot \alpha \cdot (T_p - T_0)$$

$$T_p = 130^\circ F$$
$$T_0 = 70^\circ F$$
$$\alpha = 5.838 \times 10^{-6} \ \text{in/in/F}$$

$$\delta_R = 12 \times 5.838 \times 10^{-6} \times (130 - 70) = .004203 \text{ in}$$

$$\delta_{PR} = \frac{PR^2}{2tE}(2 - \nu) = \frac{13.2 \times 10.687^2 (2 - 0.3)}{2 \times (.375 - .687) \times 27.7 \times 10^6} = .000614 \text{ in}$$

$$\therefore \delta_R = \delta_R + \delta_{PR} = .004203 + .000614$$
$$= 4.817 \times 10^{-3} \text{ in}$$

4) Structure Expansion

a) South Side Structure

$$L_s = 78.375 - (16.75 - 12) = 80.125'$$

$$\delta_{ss} = L_s \times \alpha_s (T_s - T_0)$$

$$T_s = \frac{130 + 104}{2} = 117^\circ$$

$$T_0 = 70^\circ F$$

$$\alpha = 5.791 \times 10^{-6} \ \text{in/in/F}$$

$$\delta_{ss} = 80.125 \times 5.791 \times 10^{-6} \times (117 - 70)$$
$$= .0218''$$

b) North Side Structure

$L_s = 7'' + (15.75'' - 12'') = 11.75''$

$\delta_{NS} = L_s \times \alpha \times (T_s - T)$

$= 11.75 \times 5.791 \times 10^{-6} \times (117 - 70)$
$= .0032$

5) Concrete Expansion

$\delta_{con} = \alpha \cdot l \cdot \Delta T$ — AISC 5-16

$= \frac{.02255}{130} \cdot (15.875) \times (106° - 70°) = .02167$

Thus total thermal movement

$\delta_t = 2 \times 4.817 \times 10^{-3} + .0218 + .0032 - .02167$
$= 0.012964$ in

6) Calculate generated force from total movement

$\delta_T = \frac{P}{K_N} + \frac{P}{K_S}$

$\therefore 0.012964 = \frac{P}{9.649 \times 10^5} + \frac{P}{7.132 \times 10^6}$

$P = 11016$ lb

FORM DHE-5

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

Date 9-14-84
Calc By C Lu
Chk'd & Appr'd By T Kuo
Subject CC-1-057-021-A33A

Filing Code
Sheet No. 5 of 14
G & H Job No.

check pipe local stress due to expansion load = 11016#

Ref "Stresses in Large Horizontal cylindrical pressure vessels on two saddle supports" published in september 1951 "The welding journal research supplement" by L. P. Zick page 34 & 35

The max. circumferential combined stress in shell is compressive, occurs at horn of the saddle due to local bending and direct stress.

when $L \geq 8 R_m$

$$S_4 = -\frac{P}{4t(b)} - \frac{3K_6 P}{2t^2}$$

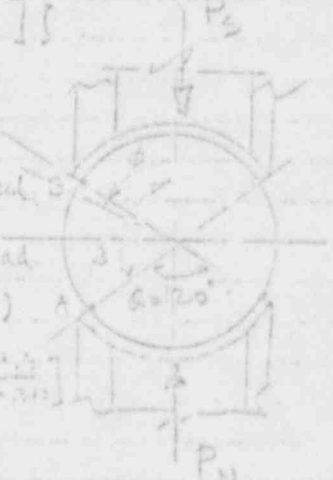
$$M_\phi = K_6 P R_m$$

b = width of saddle
t = thickness of pipe
R_m = mean radius of pipe
K_6 = stress coefficient

$$K_6 = \frac{1}{\pi}\left\{\cos\phi - \frac{\beta}{2}\sin\phi - \frac{\beta}{2}\frac{\sin\phi}{\beta} + \frac{\cos\beta}{\beta} - \frac{1}{4}\left(\cos\beta + \frac{\sin\beta}{\beta}\right) \times \left[9 - \frac{4 - 6\left(\frac{\sin\beta}{\beta}\right)^2 - 2\cos^2\beta}{\frac{\sin\beta}{\beta}\cos\beta + 1 - 2\left(\frac{\sin\beta}{\beta}\right)^2}\right]\right\}$$

when $\phi = \beta$ stress is max.

find circumferential bending stress at A & B by one trunnion load, find K_{6A} and K_{6B}



① for point A. $\phi = \beta = 120° = 2.094$ rad

$\cos\beta = -0.5$ $\sin\beta = 0.866$ ($\theta = 120°$)

$K_{6A} = \frac{1}{\pi}\{-0.75 - 0.907 - 0.62 - 0.3784 \times [9 - \frac{[illegible]}{[illegible]}]\}$

$= -0.033$

② for point B. $\phi = 60° = 1.0472$ rad, $\beta = 120° = 2.094$ rad

$K_{6B} = \frac{1}{\pi}\{0.5 + 0.4535 - 0.6283 + (-0.25) + \frac{1}{4}(0.0865)[9 - \frac{3.4741}{0.4413}]\}$

$= 0.0175$

Since two trunnion load interface each other.

$P_S = P_N = 11016\#$

$$S_{4A} = -\frac{P_N}{4t(b)} - \frac{3K_{6A} P_N}{2t^2} - \frac{3K_{6B} P_S}{2t^2}$$

$$= -11016\left[\frac{1}{4 \times 0.375(10.75)} + \frac{3\times(-0.033)}{2\times0.375^2} + \frac{3\times(0.0175)}{2\times0.375^2}\right] = 3733\ PSI$$

added to existing pipe stress and anchor load local stress $S_E = 30542$ PSI

$S = S_E + S_4 = 30542 + 3733 = 34275$ PSI < 37950 PSI O.K.

Check Support structure
a) Support structure on south side of pipe

- Max load on item #28 or #50

$A_{28} = 20.76\ in^2$

$A_{50} = 16.05\ in^2$

$F_{exp} = 11016\ lb$

$F_x = F_x + F_{exp} = 16507 + 11016 = 27523\ lb$

Ref. As-built calc sheet 12 of 55

$f_{a_{50}} = \frac{27523}{16.05} = 1715\ psi$

$f_{a_{28}} = \frac{27523}{20.76} = 1326\ psi$

From as-built calc, allowable compression stress

$F_A = 17920\ psi$

Existing as-built calc.

The overall stress (axial stress and bending stress) of item #28 (stradl member #6) is 13221.1 psi.

But existing compression stress

$f_a = \frac{F_x}{A_{28}} = \frac{16507}{20.76} = 795\ psi$

Thus existing bending stress $f_b = 13221.1 - 795 = 12426.1\ psi$

Since $\frac{f_{a28}}{F_a} = \frac{1326}{17920} = .074 < .15$

$\therefore \Sigma R = \frac{f_{a28}}{F_a} + \frac{f_b}{F_b} = \frac{1326}{17920} + \frac{12426.1}{25200} = .567 < 1.0$

Thus stress check for item #28 is O.K.

FORM DHE-5

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

Date 9-17-84
Calc By C. Liu
Checked By T. [illegible]
Subject SC-1-057-021-A33A

File Code
Sheet No. 7 of 14
G.&H. Job No.
Ref. Dwg. Dwr. No.

For the item #50 (Strudl member 4)

$$\frac{f_{am}}{F_a} = \frac{1719}{17720} = .1 < .75$$

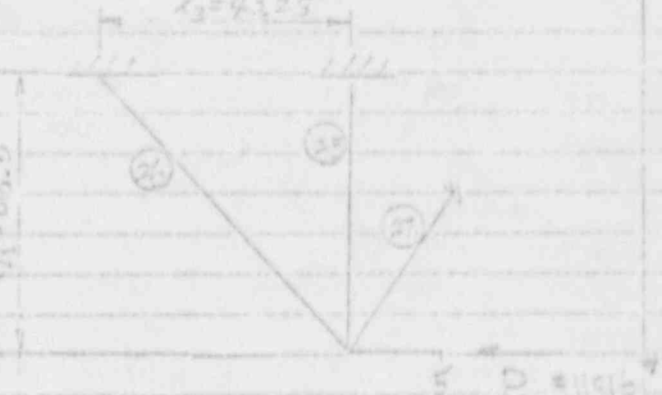
Since item #28 (STUDL member #6) is the most critical member (highest member stress), therefore the rest of member will acceptable

The extra loading generated by thermal expansion will be compression load to south side of structure. Therefore the base plate and Hilti Kwik bolt are not affected

b) Support structure on north side of pipe

Member stress

From Strudl result, Member 4 (item #50) had the highest stress on this support. As per sheet #6, it's acceptable therefore all other member will be acceptable.



Check base plate

Calculate the extra load from expansion force
assume m 27 did not pick up any force

Rigid Frame
by [illegible]

$$V_{25} = V_{26} = \frac{P \times \ell_{25}}{\ell_3} = \frac{11016 \times 66.5}{43.25} = 16938^{\text{lb}}$$

$H_{25} = 11016^{\text{lb}}$

FORM DHE-3

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

Date 9-14-84
Calc By C Lu
Checked & Appd By T. Huo
Subject CC-1-257-021-A33A

Filing Code ______
Sheet No. 8 Of 14
G & H Job No. ______
Ref. Dwg. Spec. No. ______

Ref As-built Calc

Check the worst base plate item #33. The loading combination is case #1 for load 68 in use

$F_x = 1326^{lb}$ $F_y = 7414^{lb}$ $F_z = 3493^{lb}$

$M_x = 87410^{in\text{-}lb}$ $M_y = 29947^{in\text{-}lb}$ $M_z = 31198^{in\text{-}lb}$

F [illegible] 14 = 25402#

Due to the expansion load the Fy component will increase to 24352 lb (= 7414 + 16938#). In actual base plate program, the input [illegible] was Fy of 26569 lb. It is conservative to use the higher load of Fexp = 19155# for base plate analysis.

$F_y = 7414 + 19155 = 26569^{lb}$

Transfer to PSDI base plate axes system

$F_x = 1326^{lb}$ $F_y = 3493^{lb}$ $F_z = 26569^{lb}$

$M_x = 87410^{in\text{-}lb}$ $M_y = 31198^{in\text{-}lb}$ $M_z = 29947^{in\text{-}lb}$

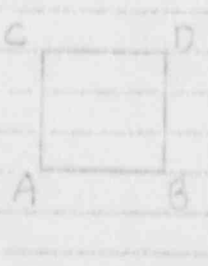
Resolve load for PSDI base plate input

$$A: \frac{26569}{4} + \frac{87410}{2\times 10} - \frac{31198}{2\times 10} = 9452^{lb}$$

$$B: \frac{26569}{4} + \frac{87410}{2\times 10} + \frac{31198}{2\times 10} = 12573^{lb}$$

$$C: \frac{26569}{4} - \frac{87410}{2\times 10} - \frac{31198}{2\times 10} = 712^{lb}$$

$$D: \frac{26569}{4} - \frac{87410}{2\times 10} + \frac{31198}{2\times 10} = 3832^{lb}$$



FORM DHE-5

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

Date 9-14-84
Calc By C. L.
Chk'd Appvd By T. K.
Subject CC-1-057-021-A33A

Filing Code
Sheet No. 9 of 14

2 of

Base Plate Analysis Result

Ref PSDI base plate analysis Dated 4-13-84

Worst bolt is #5 bolt

$f_T = 8980$ lb $f_V = 574$ lb

for 1¼ φ Super Hilti EMB = 11½

$F_T = 10735$ lb $F_V = 8295$ lb

$\therefore IR = \frac{8980}{10735} + \frac{574}{8295} = 0.91 < 1.0$ OK

$\sigma_{b2} = 8241$ psi $< 0.75\sigma_y = 28100$ psi (SA-36 Level C)

Therefore, the expansion load to the support is acceptable.

X-413

DHE-41
REV. 0

BPAT 225

BASE PLATE ANALYSIS INPUT SHEET

SHT 10 of 14

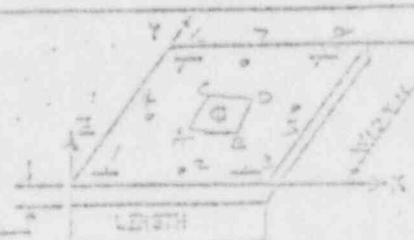
INPUT BY C. Lu DATE 8.29.84 CHECKED BY T. K DATE 8.31.84

ENTER TITLE
MK. NO. CC-1-097-021-A33A NPSI NO.

DWG REV. DWG REV.

DWG REV. DWG REV.

ITEM # 33
JOINT # 9



BOLT LOCATION

LOAD LOCATION

THICKNESS

ENTER LENGTH, WIDTH, AND THICKNESS OF BASE PLATE		
LENGTH (IN.)	WIDTH (IN.)	THICKNESS (IN.)
20	41	.5

HOW MANY BOLTS ARE THERE IN THE BASE PLATE? NO. OF BOLTS= 8

FOR EACH BOLT ENTER THE X-LOCATION; Y-LOCATION; DIAMETER AND LENGTH (OR STIFFNESS)

BOLT LOC.	X-LOCATION (IN.)	Y-LOCATION (IN.)	DIAMETER (IN.)	STIFFNESS (LBS./IN.)	PRELOAD (LBS.)
1	1.63	2.0	1.25	500,000	0
2	8.75	3.625			
3	11.45	3.5			
4	[illegible]	31.5			
5	27.875	31.64			
6	2.375	32.0			
7	14.125	32.12			
8	27.75	32.313			

HOW MANY LOAD POINTS ARE THERE IN THE PLATE? NO. OF LOAD POINTS= 5

FOR EACH LOAD POINT THE X-LOCATION; Y-LOCATION; Fx; Fy; Fz; Mx; My; Mz

CASE	LOAD PT.	X-LOC. (IN).	Y-LOC. (IN.)	Fx (LBS.)	Fy (LBS.)	Fz (LBS.)	Mx (IN-LBS.)	My (IN-LBS.)	Mz (IN-LBS.)
1	A	10.25	20.69			4452			
	B	20.25	20.69			12973			
	C	10.25	30.69			-712			
	D	20.25	30.69			3832			
	E	10.25	33.64	1306	3603				24467

Prepared by CLu
Checked by TK

SHT 11 of 14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********************************
* RESULTS OF LATEST ANALYSIS *
********************************

JOB ID - 04-13-19        JOB TITLE - CC-1-057-021-A33A (ITEM 33 JT.9)

ACTIVE UNITS -  LENGTH     WEIGHT     ANGLE     TEMPERATURE     TIME     MASS
                INCH       POUN       RAD       DEGF            SEC      LBM

BASEPLATE RESULTS SUMMARY LEVEL  1

    SPECIFIED GENERAL DATA

PLATE DIMENSION IN X  DIRECTION.......      30.000
PLATE DIMENSION IN Y  DIRECTION.......      41.000
PLATE THICKNESS.......................       1.500
PLATE MODULUS......................... 0.277000E 08
FOUNDATION MODULUS.................... 0.363000E 07
PLATE ELEMENTS TYPE...................   PBQ1     CPT

    SPECIFIED BOLT/PIN DATA

NUMBER OF BOLTS/PINS....................   8

//--NODE--/-----------------LOCATION-----------------/-BOLT/PIN-/------KF ------/-DIAMETER-//
                X            Y             Z                         AXIAL

  20501       2.4400      22.1500        0.0      4           500000.000      1.250
  20801       2.3750      28.0610        0.0      6           500000.000      1.250
  50501      13.6500       3.0630        0.0      2           500000.000      1.250
  50801      14.6700      38.1500        0.0      7           500000.000      1.250
  80501      27.9400       3.5000        0.0      3           500000.000      1.250
  80601      27.6750      21.6700        0.0      5           500000.000      1.250
  80801      27.7500      38.3100        0.0      8           500000.000      1.250
  99999002    1.6200       2.6000        0.0      1           500000.000      1.250

LOADING 1          DWE
```

Prepared by C Chu
Checked by TK

SHT 12 3/4

SPECIFIED LOAD VALUES AND THEIR LOCATIONS

NUMBER OF LOAD POINTS.................. 5

//--NODE--/	LOCATION X	LOCATION Y	LOCATION Z	FORCES X	FORCES Y	FORCES Z	MOMENTS X	MOMENTS Y	MOMENTS Z //
	10.2500	20.6900	0.0	0.0	0.0	9452.000	0.0	0.0	0.0
	20.2500	20.6900	0.0	0.0	0.0	12573.000	0.0	0.0	0.0
	10.2500	30.6900	0.0	0.0	0.0	713.000	0.0	0.0	0.0
	20.2500	30.6900	0.0	0.0	0.0	3932.000	0.0	0.0	0.0
	15.2500	25.6900	0.0	1326.000	3493.000	0.0	0.0	0.0	29947.000

COMPUTED BOLT/PIN LOADS

//--NODE--/	LOCATION X	LOCATION Y	LOCATION Z	/-BOLT/PIN-/	-AXIAL FORCE-/	SHEAR FORCES GLOBAL-X	GLOBAL-Y	SRSS //
20201	2.4400	22.1200	0.0	4	7028.113	154.631	328.325	362.916
20801	2.3750	38.0630	0.0	6	1742.566	15.010	327.756	338.099
50201	13.6300	3.0620	0.0	2	3062.558	63.714	426.383	534.137
50801	14.6900	38.1300	0.0	7	4311.506	15.423	425.672	435.910
80201	27.9400	3.5000	0.0	3	2216.922	217.885	551.781	636.799
80501	27.8750	21.6500	0.0	5	8973.682	158.466	551.211	573.543
80801	27.7500	38.3130	0.0	8	8357.173	42.879	550.116	550.265
99990082	1.6500	2.0000	0.0	1	1130.450	331.623	321.751	461.433

COMPUTED DISPLACEMENTS/ROTATIONS AT LOAD POINTS

//--NODE--/	LOCATION X	LOCATION Y	LOCATION Z	DISPLACEMENTS X	DISPLACEMENTS Y	DISPLACEMENTS Z	ROTATIONS X	ROTATIONS Y	ROTATIONS Z //
	10.2500	20.6900	0.0	0.0	0.0	0.030846	-0.000037	-0.001359	0.0
	20.2500	20.6900	0.0	0.0	0.0	0.032914	0.000084	0.001154	0.0
	10.2500	30.6900	0.0	0.0	0.0	0.035748	-0.001636	-0.000966	0.0
	20.2500	30.6900	0.0	0.0	0.0	0.023342	-0.001635	0.000631	0.0
	15.2500	25.6900	0.0	0.0	0.0	0.031681	-0.001176	-0.000284	0.0

COMPUTED MAXIMUM PRINCIPAL STRESS VALUES

MAXIMUM PRINCIPAL STRESS : 8241.06250

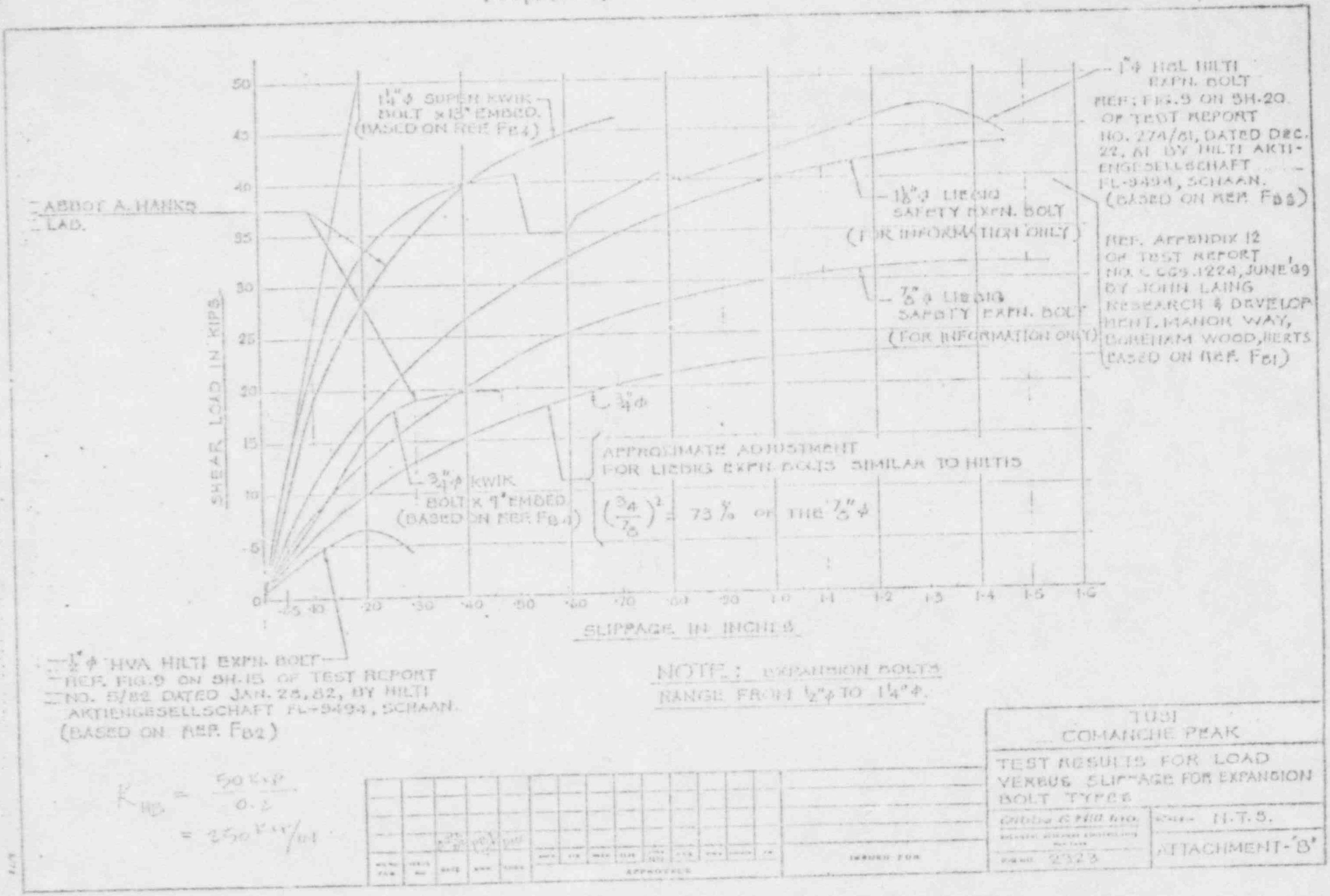
Prepared by C Lu
Checked by TK

SHT 13 of 14

ELEMENT : 60404

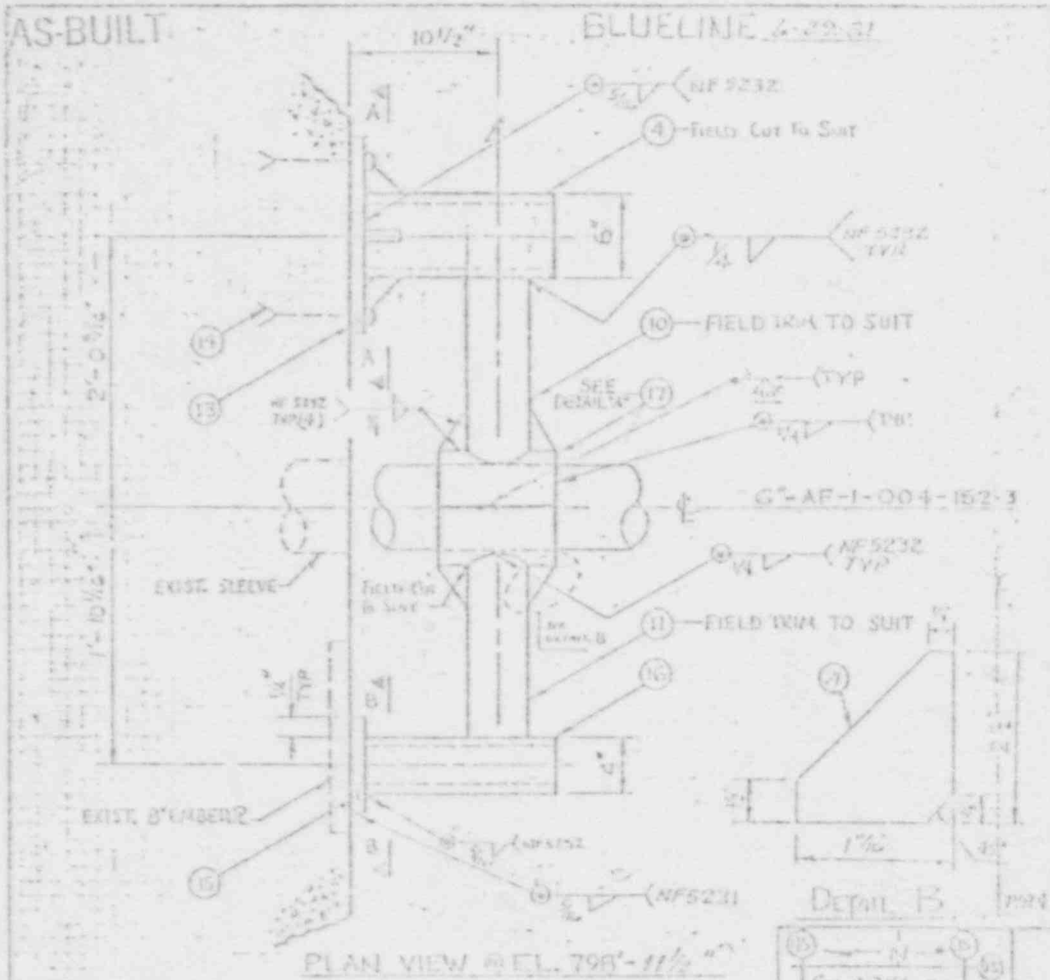
END OF FILE ENCOUNTERED

ATTACHMENT


SHEAR LOAD IN KIPS
SLIPPAGE IN INCHES
1¼"ϕ SUPER KWIK BOLT x 13" EMBED. (BASED ON REF. FB4)
ABBOT A. HANKS LAB.
1"ϕ HSL HILTI EXPN. BOLT
REF: FIG.9 ON SH-20 OF TEST REPORT NO. 274/81, DATED DEC. 22, 81 BY HILTI AKTIENGESELLSCHAFT FL-9494, SCHAAN. (BASED ON REF. FB3)
1⅛"ϕ LIEBIG SAFETY EXPN. BOLT (FOR INFORMATION ONLY)
⅞"ϕ LIEBIG SAFETY EXPN. BOLT (FOR INFORMATION ONLY)
REF. APPENDIX 12 OF TEST REPORT NO. C 669.1224, JUNE '69 BY JOHN LAING RESEARCH & DEVELOPMENT, MANOR WAY, BOREHAM WOOD, HERTS (BASED ON REF. FB1)
¾"ϕ
¾"ϕ KWIK BOLT x 7" EMBED. (BASED ON REF. FB4)
APPROXIMATE ADJUSTMENT FOR LIEBIG EXPN. BOLTS SIMILAR TO HILTIS
$\left(\frac{3/4}{7/8}\right)^2 = 73\%$ OF THE ⅞"ϕ
½"ϕ HVA HILTI EXPN. BOLT
REF. FIG.9 ON SH-15 OF TEST REPORT NO. 5/82 DATED JAN. 28, 82, BY HILTI AKTIENGESELLSCHAFT FL-9494, SCHAAN. (BASED ON REF. FB2)
NOTE: EXPANSION BOLTS RANGE FROM ½"ϕ TO 1¼"ϕ.
$K_{HB} = \frac{50\ KIP}{0.2} = 250\ KIP/IN$
TUSI
COMANCHE PEAK
TEST RESULTS FOR LOAD VERSUS SLIPPAGE FOR EXPANSION BOLT TYPES
GIBBS & HILL, INC.
N.T.S.
2323
ATTACHMENT-'B'
APPROVED
ISSUED FOR

E' Att 'E'

AS-BUILT



NOTES:
BY ISSUE OF REV. 5 OF THIS DRAWING THE FOLLOWING DOCUMENTS ARE VOIDED:
-CMC 94706 R.1

NOTE:
5) Locking devices for high strength bolts are not required per DCA 7507

ITEM NO.	MATERIALS & OPERATIONS	QUAN	SHIP
	SEISMIC PIPE RESTRAINT CONSISTING OF:		
4	[illegible]	1	
10	[illegible] STANCHION FOR [illegible]	1	
11	[illegible] STANCHION FOR [illegible]	1	
12	[illegible]	1	
13	[illegible]	1	
14	[illegible]	4	
15	[illegible]	1	
16	[illegible]	1	
17	[illegible] PER DETAIL "A" (FIELD TRIM TO SUIT)	2	
18	[illegible]	1	
19	[illegible]	1	
20	[illegible]	1	
21	[illegible]	4	
	SEISMIC ASSEMBLY SKETCH AND ENGINEERING MARKLE AND TAG	1	

FOR OFFICE AND ENGINEERING USE ONLY

VENDOR CERTIFIED
DRAWING REV. NO. 5
BY [illegible] DATE [illegible]

REV	DATE	DR	CHK	APR	DESCRIPTION
					Vendor Certification [illegible]
4					REV. VENDOR CERT.
5					[illegible]

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS
PIPE: [illegible] ELECT: [illegible]
STEEL: [illegible] HVAC: [illegible]

CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EMERGENCY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FAULTED						

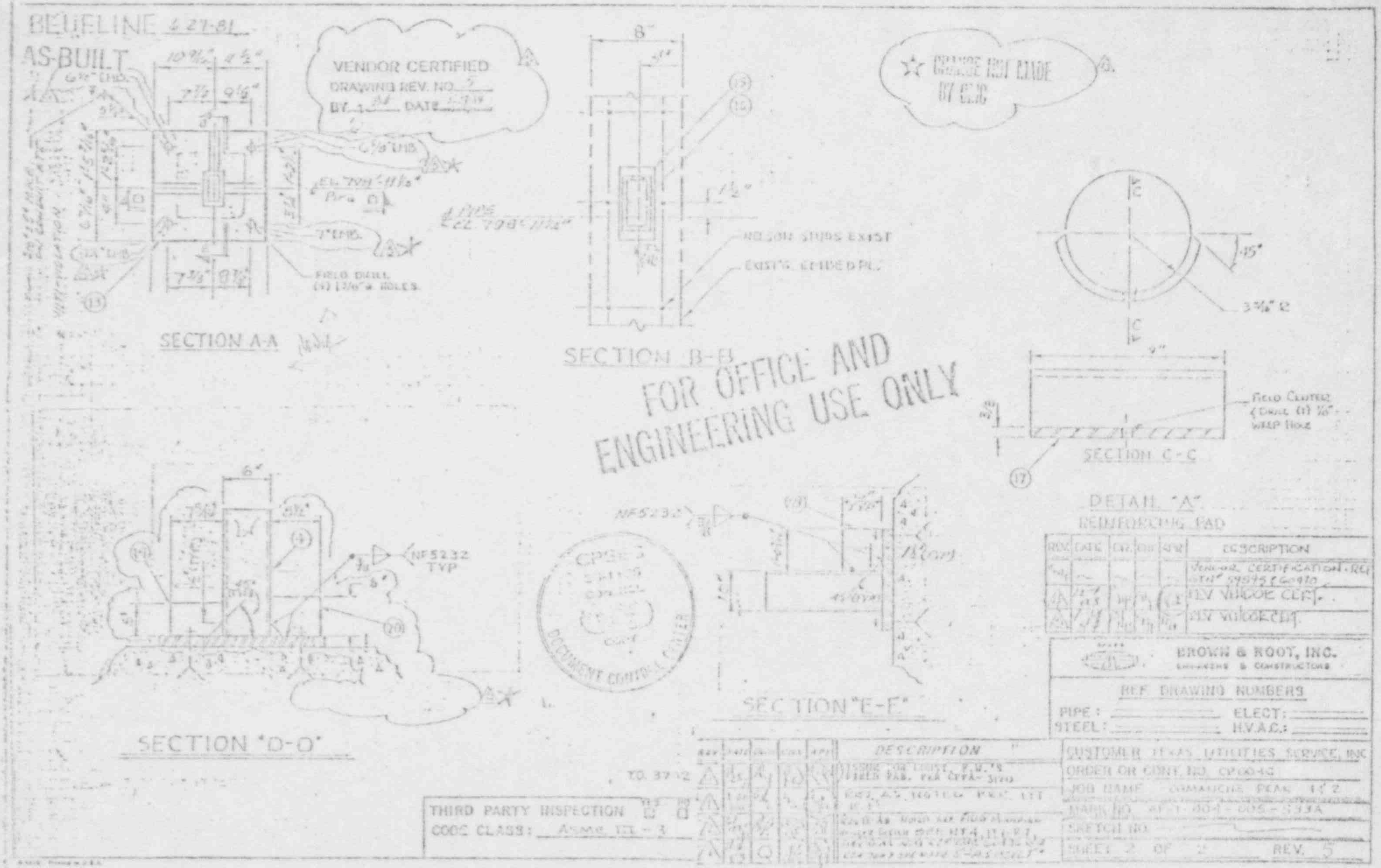
Bril. No. AF-1-58-01 SO
F.P.O. [illegible]
Pipe Mat'l. SA 106 [illegible]
Insul. [illegible]

THIRD PARTY INSPECTION
CODE CLASS: ASME III - 3

REV	DESCRIPTION
A	ISSUED FOR CONST. [illegible]
1	REV AS NOTED PER [illegible]
2	REVD AS NOTED SEE FIELD [illegible]

CUSTOMER TEXAS UTILITIES SERVICE, INC.
ORDER OR CONT. NO. CP-0016
JOB NAME COMANCHE PEAK 1 & 2
MARK NO. AF-1-004-005-S33A
SKETCH NO.
SHEET 1 OF 2 REV. 5

Att. E'


BLUELINE 6-27-81
AS-BUILT
VENDOR CERTIFIED
DRAWING REV. NO. 5
SECTION A-A
8"
NELSON STUDS EXIST
EXIST'G EMBED PL.
SECTION B-B
FOR OFFICE AND
ENGINEERING USE ONLY
45°
SECTION C-C
FIELD DRILL
DETAIL "A"
REINFORCING PAD
6"
NF5232
TYP
SECTION "D-D"
DOCUMENT CONTROL CENTER
SECTION "E-E"
DESCRIPTION
BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS
REF DRAWING NUMBERS
PIPE:
ELECT:
STEEL:
H.V.A.C.:
CUSTOMER TEXAS UTILITIES SERVICE, INC
ORDER OR CONT. NO.
JOB NAME COMANCHE PEAK 1 & 2
MARK NO.
SKETCH NO.
SHEET 2 OF 2
REV. 5
THIRD PARTY INSPECTION
CODE CLASS: ASME III - 3

E.

FORM DHE-5

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

Date 8.22.84
Calc By T. Kun
Chk & Apprd. By C. Li
Subject AF-1-004-005-S33A R-5

Filing Code
Sheet No. 1 of 15
G & H Job. No.
Ref. Dwg. Spec. No.

		REF
LINE NO	6AF-1-004-151-3	LINE LIST
OPERATING TEMPERATURE	120 °F	
OPERATING PRESSURE	50 PSI	
PIPE DIAMETER	6.625" Ø	
THICKNESS, PIPE WALL	0.28"	
MAT'L	SA 106 GR. B	

CALCULATE THE STIFFNESS OF EAST AND WEST SIDE STRUCTURE.

MEMBER PROPERTIES

TS 10x6x 1/2   A = 14.6 IN²
I_x = 181 IN⁴ S_x = 36.2 IN³
I_y = 80.5 IN⁴ S_y = 26.9 IN³

TS 8x4x 3/8   A = 8.08 IN²
I_x = 61.9 IN⁴ S_x = 15.5 IN³
I_y = [illegible] IN⁴ S_y = 10.3 IN³

5"Ø SCH 120   OD = 5.563 IN
A = 7.95 IN²
I = 25.7 IN⁴   S = 9.25 IN³

② EAST STRUCTURE
(ASSUME BEAM AB AS GUIDED CANTILEVER BEAM).

$K_{EF} = \frac{AE}{L} = \frac{7.95 \times 27.7 \times 10^6}{17.875} = 12.3 \times 10^6$ #/in

$K_{CD} = \left(\frac{L^3}{12EI} + \frac{L}{GA_s}\right)^{-1} + \left(\frac{L^3}{[illegible] \times 10^6 \times 80.5} + \frac{L}{[illegible] \times 10^6 \times [illegible]}\right)^{-1}$

$= 5.933 \times 10^6$ #/in

* ANCHOR SHEAR SLIPPAGE (4 - 1½" Ø HILTI - KWIK BOLT)
K_{HB} = 200K #/in × 4 = 8.0 × 10⁵ #/in   —— Ref. ATTACHMENT 'A'   SHEAR STIFF REF. TO SEC 6.11 MECHANICS OF MATERIAL BY TIMOSHENKO & GERE.

$K_E = (K_{EF}^{-1} + K_{CD}^{-1} + K_{HB}^{-1})^{-1} = 6.67 \times 10^5$ #/in

FORM DHE-5

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

Date: 8.22.86
Calc By: T. KUO.
Chk'd Appd By: C. L.
Subject: AF-1-004-005-S22A, R.5
Filing Code:
Sheet No. 2 of 15
Q & H Job No.
Ref. Dwg./Doc. No.

REF.

(5) WEST STRUCTURE
(ASSUME CD IS GUIDED CANTILEVER BEAM)

$K_{CD} = \frac{AE}{l} = \frac{7.93 \times 27.7 \times 10^6}{16.375}$

$= 13.45 \times 10^6$ #/in

$K_{DE} = \left(\frac{l^3}{12EI} + \frac{l}{GA_s} \right)^{-1} = \left(\frac{9.5^3}{[illegible]} + \frac{9.5}{[illegible]} \right)^{-1}$

$= 2.367 \times 10^6$ #/in

(SHEAR DEFORMATION — MECHANICS OF MATERIALS — [illegible] — SHEET [illegible])

* ANCHOR SHEAR SLIPPAGE (4 - 3/4" ∅ NELSON STUD)
$K_{E} = 4 \times 2.4 \times 10^6$ #/in $= 9.6 \times 10^6$ #/in   Ref: ATTACHMENT 5

$K_W = \left(K_{CD}^{-1} + K_{DE}^{-1} + K_{NE}^{-1} \right)^{-1} = 1.664 \times 10^6$ #/in

PIPE STIFFNESS

* THERE IS NO SIMPLE FORMULA FOR DISPLACEMENTS CALCULATION FOR CYLINDRICAL SHELL UNDER PARTIAL LOADED CASES. THE PIPE IS ASSUMED TO BE RIGID FOR CONSERVATISM.

CALCULATE THE THERMAL EXPANSIONS

THE THERMAL EXPANSION COEFFICIENT IN/IN/°F

	100°F	120°F	150°F
SA-106 GR. B	5.73×10^{-6}	5.8×10^{-6}	5.91×10^{-6}
A-500 GR. B	6.5×10^{-6}		6.57×10^{-6}

(ASME SEC. III NA, APP. I, TABLE I-5.0)

a. PIPE THERMAL EXPANSION & PRESSURE DILATION.

$\delta_T = \alpha \times D \times (T - T_A)$

$= 5.8 \times 10^{-6} \times 6.625 \times (120 - 70)$

$= 1.92 \times 10^{-3}$ in

FORM DHE-5

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

Date 8-22-86

Calc By T. KUO

Checked By C. Lu

Subject HF-1-004-005-S33A R-5

Filing Code ______

Sheet No. 3 of 15

C & H Job No. ______

Ref. Dwg. Spec. No. ______

REF.

CALCULATE THE PRESSURE DILATION

$$\delta_p = \frac{P r^2}{E t}\left(1 - \frac{\mu}{2}\right)$$

$$= \frac{50 \times (6.625/2 + 0.375)^2}{27.7 \times 10^6 \times (0.5 + 0.375)}\left(1 - \frac{0.3}{2}\right)$$

$$= 3.135 \times 10^{-5} \text{ IN.}$$

$$\delta_{pipe} = \delta_T + 2 \times \delta_p$$

$$= 1.856 \times 10^{-3} \text{ IN}$$

D. EXPANSION OF TRUNNIONS

$$T_S = \frac{T + T_0}{2} = \frac{120 + 104}{2} = 112\ ^\circ F$$

$\alpha = 5.773 \times 10^{-6}$ IN/IN/°F AT @ 112 °F

$$\delta_E = \alpha \times l_E \times (T_S - T_A)$$

$$= 5.773 \times 10^{-6} \times 21.25 \times (112 - 70)$$

$$= 5.152 \times 10^{-3} \text{ IN.}$$

$$\delta_W = \alpha \times l_W \times (T_S - T_A)$$

$$= 5.773 \times 10^{-6} \times 18.75 \times (112 - 70)$$

$$= 4.546 \times 10^{-3} \text{ IN}$$

C. CONCRETE EXPANSION FROM INSTALLATION TEMP. (70°F) TO AMBIENT TEMP. (104°F)

$\alpha_{con} = 5.5 \times 10^{-6}$ IN/IN/°F — AISC 6-13 7th ED.

$$\delta_{con} = \alpha_{con} \times 46.625 \times (104 - 70) = 8.719 \times 10^{-3} \text{ IN.}$$

<u>NET EXPANSION</u>

$$\delta_{NET} = \delta_{PIPE} + \delta_E + \delta_W - \delta_{con} = 2.983 \times 10^{-3} \text{ IN.}$$

FORM DHE-5

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

Date 8-22-84
Calc By T. KUO
Chk'd Appr. By C Lu
Subject LF-1-004-005-S33A R-5

Filing Code
Sheet No. 4 Of 15
G & H Job No.
Ref. Dwg. Spec. No.

REF.

TOTAL LOAD BETWEEN PIPE AND TRUNNION DUE TO THERMAL EXPANSION

$$\delta = \frac{P}{K_{S}} + \frac{P}{K_{n}}$$

$$2.963 \times 10^{-3} = P[(6.67\times10^{5})^{-1} + (1.664\times10^{6})^{-1}]$$

$$2.963\times10^{-3} = P \times 2.123\times10^{-6}$$

$$P = 1411 \text{ lb}$$

CHECK PIPE LOCAL STRESSES DUE TO $P_{EXP} = 1411$ lb (IGNORE GUSSET PLATES CONTRIBUTION) — WRC-107

$$R_m = \frac{6.625 - 0.28 + 0.375}{2} = 3.36 \text{ IN}$$

$$r_0 = \frac{5.563}{2} = 2.7815''$$

∴ SUFFICIENT WELDS BETWEEN THE PAD AND PIPE EXIST, ASSUME COMPOSITE ACTION.

$$T = 0.28 + 0.375 = 0.655''$$

$$\beta = 0.875 \times \frac{r_0}{R_m} = 0.875 \times \frac{2.7815}{3.36} = 0.724 > 0.5$$

MODIFICATION REQUIRED, ASSUME FICTITIOUS LARGE PIPE SIZE, REDUCE β TO 0.5 FOR CONSERVATIVE RESULT

IF $\beta = 0.5$

$$R_m = 0.875 \times \frac{r_0}{\beta} = 0.875 \times \frac{2.7815}{0.5}$$

$$= 4.8676 \text{ IN.} \quad \text{— WHERE } \beta = 0.5.$$

$$\gamma = \frac{R_m}{T} = \frac{4.8676}{0.655} \doteq 7.5.$$

FIG

$$\sigma_\phi \begin{cases} 3C/4C & 1.0 \quad (N_\phi/\tfrac{P}{R_m})(\tfrac{P}{R_m T}) = 1.0\times(\tfrac{1411}{4.8676\times0.655}) = 443 \\ 1C/2C\text{-}1 & 0.054 \quad (M_\phi/P)(\tfrac{6P}{T^2}) = 0.054(\tfrac{6\times1411}{0.655^2}) = 1066 \end{cases} \quad 1509 \text{ PSI}$$

$$\sigma_x \begin{cases} 3C/4C & 1.0 \quad (N_x/\tfrac{P}{R_m})(\tfrac{P}{R_m T}) = 1.0(\tfrac{1411}{4.8676\times0.655}) = 443 \\ 1C\text{-}1/2C & 0.05 \quad (\tfrac{M_x}{P})(\tfrac{6P}{T^2}) = 0.05(\tfrac{6\times1411}{0.655^2}) = 987 \end{cases} \quad 1430 \text{ PSI}$$

FORM DHE-5

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

Date 3.22.84
Calc By T Kuo
Chk & Appvd By C Lu
Subject AF-1-052-009-S33A R-5
Filing Code
Sheet No. 3 of 15
G & H Job No.
Ref Dwg/Spec No.

	REF.
EXISTING ANCHOR LOAD LOCAL PIPE STRESS FROM G & H ON EQ. 11.	
$S_{EQ\ 11} = 30730$ PSI	
$S_{EXP} = 1509$ PSI	PSE
$S = 30730 + 1509 = 32239$ PSI $< S_a + S_h = 37500$ PSI O.K	BUILDING LINE SEC. III
CHECK MEMBER STRESS DUE TO THERMAL EXPANSION LOAD	
② TRUNNION 5" ϕ SCH 120. $A = 7.95\ in^2$ $S = 9.25\ in^3$ $r = 1.795$ in	
$f_a = \frac{P_{exp}}{A} = \frac{1411}{7.95} = 178$ PSI.	
$\frac{Kl}{r} = \frac{2.1 \times 20.875}{1.795} = 24.4$ $S_y = 31.9$ KSI @ 260°F SA-106 GR B	
$\therefore F_a = 18.03$ KSI.	SEC. III
$\frac{f_a}{F_a} = \frac{178}{18030} = 0.0099 < 0.15$.	
$f_b = \frac{M}{S} = \frac{\frac{1}{2} P l_E}{S} = \frac{0.5 \times 1411 \times 9}{9.25}$	
$= 686$ PSI.	
INTERACTION $\frac{f_a}{F_a} + \frac{f_b}{F_b} = 0.0099 + \frac{686}{0.6 \times 31900} = 0.046$	
FROM EXISTING CALCULATION INTERACTION = 0.614	AS-BUILT REV-0 CALC. SHEET 3
TOTAL INTERACTION = 0.614 + 0.046 = 0.66 < 1 O.K	
① TUBE STEEL MEMBER C.D.	
$P_V = 1411$ #	
$M = \frac{1}{2} P_V l_W = \frac{1}{2} \times 1411 \times 9.5 = 6702$ in-#	

FORM DHE-5

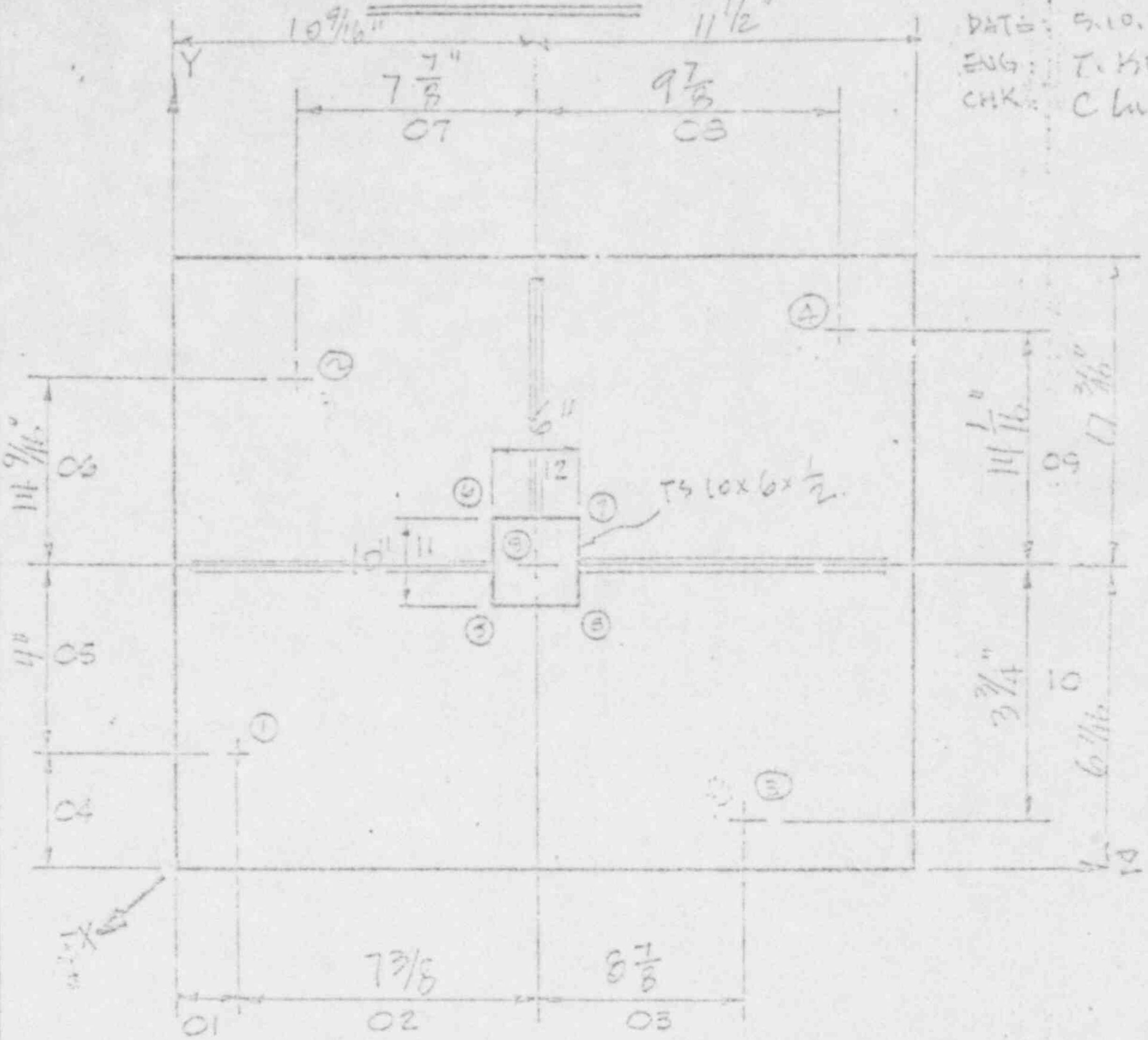
TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 8.22.84
Calc By T. Kuo
Chk'd Appd. By C. L.
Subject AF-1-?-??5-?35A 6.5
Filing Code
Sheet No 6 Of 15
G & H Job No
Ref. Dwg Spec No

	REF
TS 8×4×3/8 A = 8.08 in² S = 10.3 in³	
BENDING STRESS	
$f_b = \frac{M}{S} = \frac{6702}{10.3} = 651$ PSI	
MAX. STRESS = 5661 PSI	EXISTING AS-BUILT CALC. PSE & L SEC. I
TOTAL STRESS = 5661 + 651 = 6312 PSI < 33000 PSI O.K.	
SHEAR STRESS $f_v = \frac{P_v}{A} = \frac{1411}{2 \times 0.375 \times 4} = 470$ PSI	
MAX. SHEAR STRESS = 3152 PSI	
TOTAL SHEAR STRESS = 3152 + 470 = 3622 PSI < 15300 PSI	-//-
② CHECK BASE PLATE AND LOCALIZED STRESS BETWEEN GUSSETS AND TUBE STEELS	
CHECK THE CRITICAL PLATE (SEC A-4 EAST PLATE)	
EXTRA LOAD FROM PIPE THERMAL EXPANSION LOAD	
※ $F_z = 1411$ #	
$M_y = \frac{1}{2} \cdot 1411 \times 9 = 6350$ "#	
* NOTE: THE LOADS USED IN PSDI BASE PLATE ANALYSIS ARE: $F_z = 4355$ #, $M_y = 39195$ "#	
SINCE THESE LOADS ARE HIGHER THAN ACTUAL EXPANSION LOAD, IT IS CONSERVATIVE	
ADD $F_z = 4355$ lb & $M_y = 39195$ in-lb TO BASE PLATE LOAD DUE TO ORIGINAL ANCHOR LOAD (EXIST. STRUCT. LOAD 53)	
$F_x = -3049$ # $M_x = 6236$ "#	LOAD FROM EXISTING AS-BUILT CALC.
$F_y = 849$ # $M_y = 38622 + 39195 = 77817$ "#	
$F_z = 1749 + 4355 = 6104$ # $M_z = -12728$ "#	

"DIM"

DATE: 5.10.84
ENG: T. KWO
CHK: C Lu



SECT. A-A

Fx =	-3049 #	14
FY =	849 #	15
Fz =	6104 #	16
Mx =	6236 "#	17
MY =	77817 "#	18
Mz =	-12728 "#	

SUPPORT # AF-1-004-005-S33A, R-5

FORM DHE-5

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

Date 05/03/84

Calc By [illegible] 05/03/84 / T. Kuo

Chk'd/Apprd. By C [illegible]

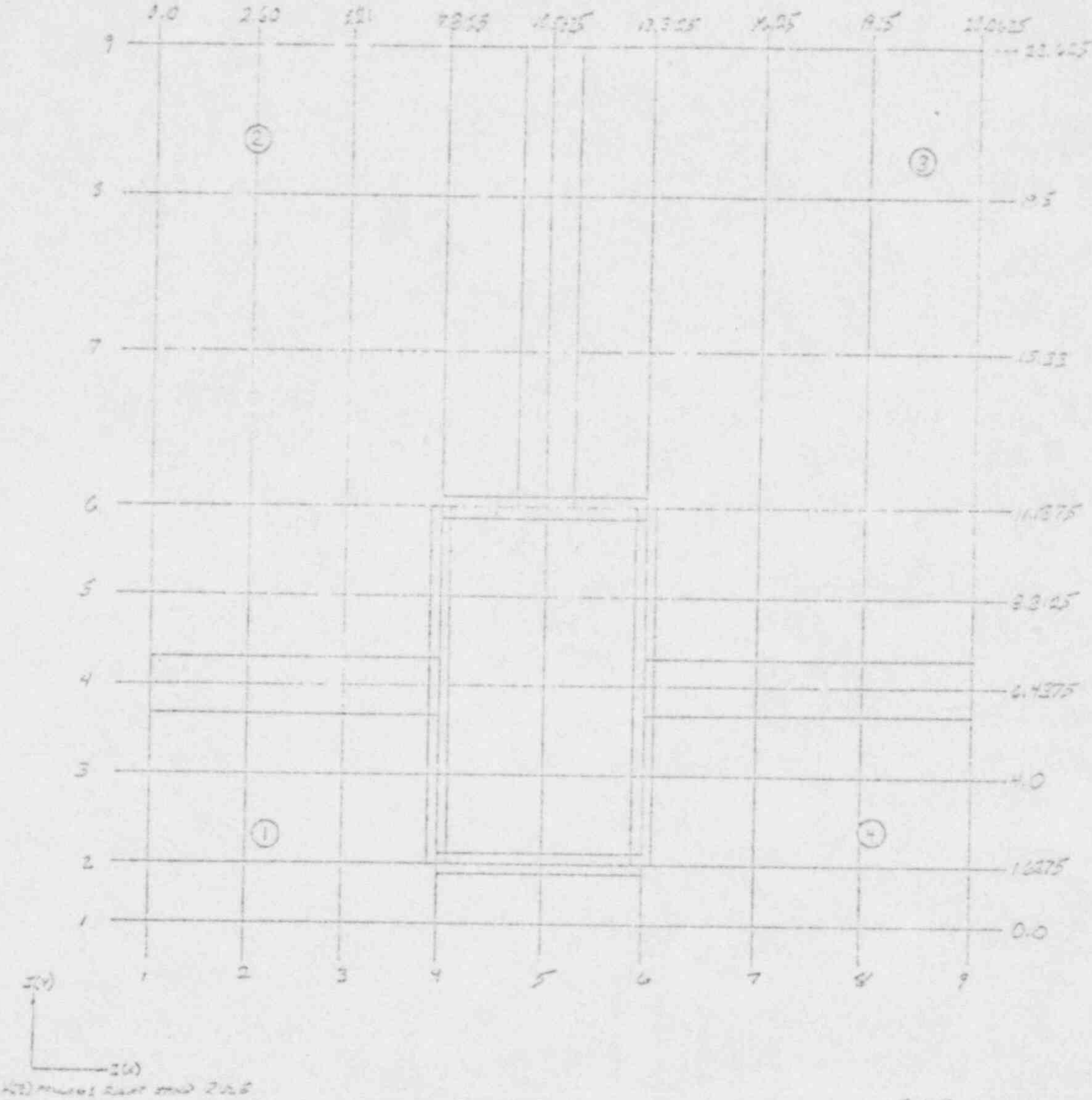
Subject AE-1-SO4-005-S33-1 [illegible]

Filing Code ____

Sheet No. 8 of 15

G & H Job. No. ____

Ref. Dwg./Spec. No. ____



BOLT	X	Y
1	3.1875	2.4375
2	2.6875	21.0
3	20.4375	20.5
4	19.4375	2.6875

FORM DHE-5

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

Date 5-10-86
Calc By T. KUO.
Chk'd/Apprd By C. Lu
Subject AF-1-004-005-S33A K-5
Filing Code
Sheet No. 9 of 15
G. & H. Job No.
Ref. Dwg./Spec. No.

	REF
RESULT FROM PSDI FINITE ELEMENT ANALYSIS.	
ⓐ LOCAL STRESS BETWEEN GUSSETS PLATE TO TUBE STEEL	PSE GUIDELINE
1. WEST GUSSET PLATE TO TUBE STEEL	
σ_p = 3774.9 PSI. < $\sigma_1+\sigma_2$ = 26100 psi LEVEL C. O.K.	SEC III FIG. C
2. UPPER GUSSET PLATE TO TUBE STEEL.	
σ_p = 1392 PSI < $\sigma_1+\sigma_2$ = 26100 PSI LEVEL C. O.K.	-11-
3. EAST GUSSET PLATE TO TUBE STEEL.	
σ_p = 6646.2 PSI < $\sigma_1+\sigma_2$ = 26100 PSI. LEVEL C. O.K.	-11-
ⓑ BASE PLATE RESULT.	
1. MAX. BOLT LOAD IS BOLT #1	
f_t = 4547 #	
f_v = 1904 #.	
σ = 6646.2 PSI < $\sigma+\sigma$ = 26100 psi LEVEL C.	-11-
HILTI KWIK BOLT 1/2" Ø. ACTUAL EMB = 7 1/4"	EXISTING
TRUE EMB. = 7.25 + 1 1/4 = 8 1/2. ADD 1 NUT HIGH (CEI - 20).	AS-BUILT CALC.
F_t = 6920 #	
F_v = 7136 #	

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

FORM DHE-5

Date 5.10.84
Calc By T. Kuo
Chk'd Apprd By C. Lu
Subject AF-1-004-005-S33A R-3

Filing Code
Sheet No. 10 of 15
C & H Job No.
Ref Dwg. Spec. No.

	REF
BOLT INTERACTION.	
$\frac{f_t}{F_t} + \frac{f_v}{F_v} = \frac{4547}{6920} + \frac{1904}{7136}$	
$= 0.92 < 1$ O.K.	
2. CHECK BOLT #2. WITH SEPARAT[illegible] VIOLATION.	
$f_t = 1329$ #	
$f_v = 1155$ #	
HILTI KWIK BOLT $1\frac{1}{4}$" ϕ, EMB. $= 6\frac{1}{2} + 1\frac{1}{4} = 7\frac{3}{4}$	CEI-20
SEPARATION RATIO $= \frac{5.25}{(\text{[illegible]})} = 0.6462 < 0.8$	PSE GUIDELINE SEC. V FIG. 6A
$\therefore F_t = 6220 \times 0.6462 \times 1.25 = 5024$	
$F_v = 7136 \times 0.6462 \times 1.25 = 5764$	
$\frac{f_t}{F_t} + \frac{f_v}{F_v} = \frac{1329}{5024} + \frac{1155}{5764}$	
$= 0.46 < 1$, O.K	

FORM DHE-5

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

Date 8.22.84

Calc By T. Klo

Chk'd/Appd By C Lu

Subject [illegible]-1-004-003-[illegible]

Filing Code

Sheet No 11 of 15

G & H Job No

Ref Dwg Spec No

REF

CHECK PUNCHING SHEAR STRESS AT B, D.

@ JOINT B (TS 10x6x1/2 TO 5" Φ PIPE). — ANSI B31.1 SEC 10

$P_{EXP} = 1411$ #

MAX MEMBER FORCE DUE TO ANCHOR LOAD (LOAD CASE 29) ADDED $P_{EXP} = 1411$ # (LOCAL COORDINATE SYS). — [illegible] CALC.

$M_Y = 6350$ "#

$F_X = -4240 - 1411 = -5651$ # $M_X = -10052$ "#

$F_Y = 551$ # $M_Y = 24254$ "# $- 6350$ "# $= 30604$ "#

$F_Z = -16$ # $M_Z = -3781$ "#

BRANCH MEMBER IS 5" Φ PIPE:
A = 7.93 in², S = 9.25 in³, [illegible]

ACTING $V_P = \tau (f_a + f_b')$ — ANSI B31.1 SEC 10

$\tau = \frac{0.2}{[illegible]} = 1$.

$f_a = \frac{F_X}{A} = \frac{5651}{7.93} = 711$ PSI.

$f_b' = \frac{(M_Y^2 + M_Z^2)^{\frac{1}{2}}}{S} = \frac{(30604^2 + 3781^2)^{\frac{1}{2}}}{9.25}$

$= 3334$ PSI

ACTING $V_P = 1 (711 + 3334) = 4045$ PSI

ALLOWABLE $V_P = Q_\beta Q_f$ (BASIC V_P).

$\beta = \frac{b}{D} = \frac{5.563}{10} = 0.556 < 0.8$.

$Q_\beta = \frac{0.25}{\beta(1-\beta)} = \frac{0.25}{0.556 \times (1-0.556)} = 1.013$.

$U = \frac{f_{a\,MAIN\,MEMBER}}{F_b} = \frac{2282.6}{25200} = 0.09 < 0.44$ — MAIN MEMBER MAX STRESS [illegible] AS-[illegible] CALC

FORM DHE-5

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

Date 8.22.84
Calc By T Kuo
Chk'd & Appvd. By C Lu
Subject AF-1-004-005-S32A F.S
Filing Code
Sheet No. 12 of 15
G & H Job No.
Ref. Dwg./Spec. No.

REF.

$\therefore G_f = 1$

BASIC $V_p = \frac{F_y}{0.6 r}$

$r = \frac{D}{2t_c} = \frac{10}{2(0.5)} = 10.$

$F_y = 35300$ PSI   A-500 GR B @ 200 °F

$\therefore$ ALLOW $V_p = 1.013 \times 1 \times \frac{35300}{0.6 \times 10} \times \frac{4}{3}$ (INCREASE 1/3 FOR EMERGENCY LOAD)

$= 8022$ PSI > ACTING $V_p = 4075$ PSI

② JOINT D (TS 8x4x3/8 & 5"φ SCH 120)

$P_{exp} = 1411$ #

MAX. MEMBER FORCE DUE TO ANCHOR LOAD (CASE 35) ADDED EXPANSION LOAD ($F_x' = P_{exp} = 1411$ #)   EXIST. ASHBY'S CALC.

$M_y' = 6702$ "#

$F_x = 3000 + 1411 = 4411$ # $M_x = -10695$ "#

$F_y = -930$ # $M_y = -17571$ "# $- 6702$ "# $= -24273$ "#

$F_z = 3977$ # $M_z = -1833$ "#

BRANCH MEMBER 5"φ SCH 120.

ACTING $V_p = \tau (f_a' - f_b')$

$\tau = \frac{t_b}{t_c} = \frac{0.5}{0.375} = 1.3333$

$f_a' = \frac{F_x}{A} = \frac{4411}{7.95} = 555$ PSI.

$f_b' = \frac{(M_y^2 + M_z^2)^{\frac{1}{2}}}{S} = \frac{(24273^2 + 1833^2)^{\frac{1}{2}}}{9.25} = 2632$ PSI

REF

ACTING $V_p = \tau(f_a' + f_b')$ — AWS D1.1 SEC. 10.

$= 1.333(555 + 2632)$

$= 4249$ PSI

ALLOWABLE $V_p = Q_\beta Q_f$ (BASIC V_p) — —11—

$\beta = \frac{d}{D} = \frac{5.563}{8} = 0.7$

$Q_\beta = \frac{0.25}{\beta(1-\beta)} = \frac{0.25}{0.7(1-0.7)} = 1.191$

$U = \frac{f_{a,comp}}{F_a} = \frac{3061}{35200} = 0.145 < 0.44$ — [illegible]

$Q_f = 1$

BASIC $V_p = \frac{F_y}{0.6\gamma}$

$\gamma = \frac{D}{2t_c} = \frac{8}{2 \times 0.375} = 10.667$

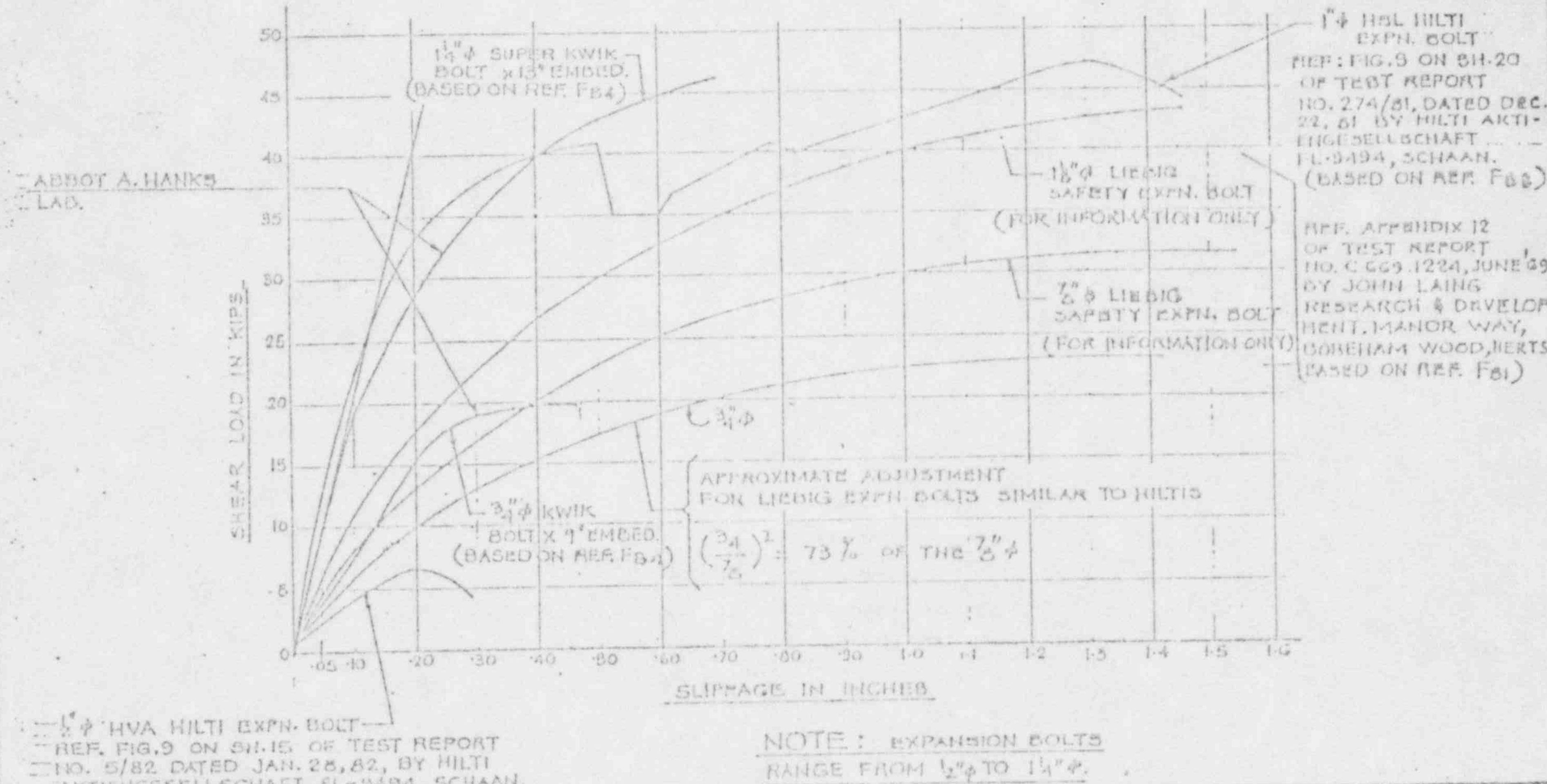
$F_y = 38300$ PSI @ 200°F A-500 GR. B.

ALLOW. $V_p = 1.191 \times 1 \times \frac{38300}{0.6 \times 10.667} \times \frac{4}{3}$ (INCREASE $\frac{1}{3}$ FOR EMERGENCY LOADS)

$= 9503$ PSI $>$ ACTING $V_p = 4249$ PSI

O.K

THE PUNCHING SHEAR STRESS ARE WITHIN ALLOWABLE.



NOTE : EXPANSION BOLTS RANGE FROM ½"φ TO 1¼"φ.

TUSI
COMANCHE PEAK

TEST RESULTS FOR LOAD VERSUS SLIPPAGE FOR EXPANSION BOLT TYPES

Gibbs & Hill, Inc.

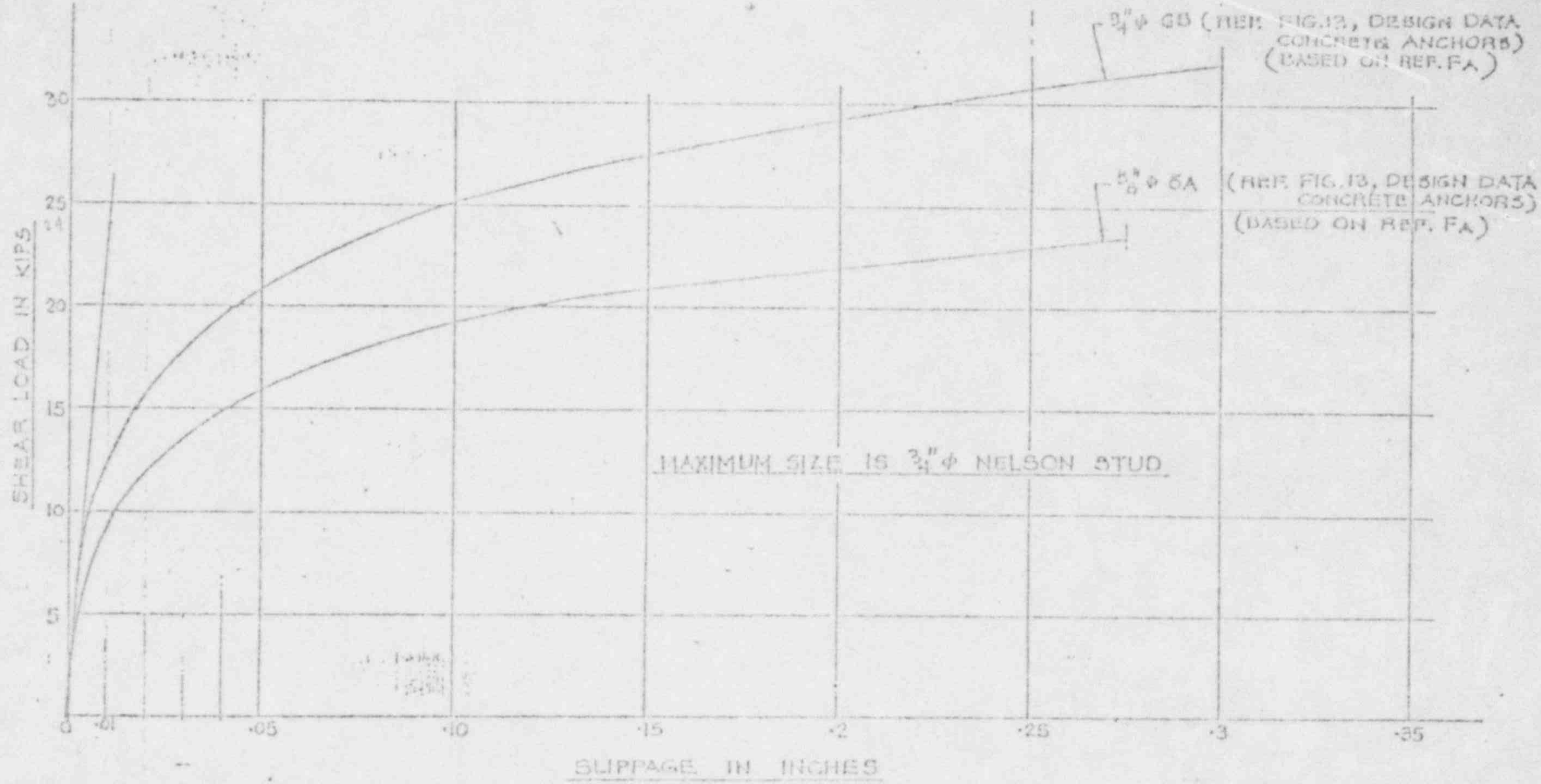
SCALE: N.T.S.

2323

ATTACHMENT-"B"

ATTACHMENT E

Sheet: 3B of



$K = \frac{24 \text{ kip}}{0.01''} = 2400 \text{ kip/in}$

TUSI COMANCHE PEAK	
TEST RESULTS FOR SHEAR LOAD VERSUS SLIPPAGE FOR NELSON STUD TYPES	
Gibbs & Hill Inc.	SCALE - N.T.S.
2323	ATTACHMENT "A"