

CALCULATION CONTROL SHEET

CALC. SET NO.

PRELIM.

FINAL

9763-B-04-00-12

VOID

PROJECT TITLE PSNH-SEABROOK UNITS 1 & 2 DISCIPLINE PSGSYSTEM REACTOR COOLANT -49 SYSTEMSUBJECT PIPE WHIP RESTRAINTS IN THE CONTAINMENTDESIGN CLASSIFICATION STRUCTURAL (NOT SAFETY RELATED)STARTED BY B. RANGANATHANDATE 1-16-81AUTHORIZED BY GEORGE CARLDATE 9-24-76

PROBLEM STATEMENT

Pipe rupture restraints (PRR's) PW-49-1, PW-49-2, PW-49-4b, PW-49-3a, PW-49-4a and PW-49-3b for the Reactor Coolant -49 system in the containment are required to control motions and absorb the energy released from a postulated pipe rupture.

Analysis must be performed for these PRR's to show that they are capable of withstanding dynamic loads resulting from energy released of the ruptured pipes while maintaining their structural integrity. The blowdown force and applied load directions were provided by the project. (see references 4,5)

DESIGN BASIS

The basis for the designs and analysis of the PRR structures is the ASME III Code, subsection NF and related subarticles addressing linear type of structures.

Since this code is not mandatory for the PRR designs, only those sections deemed appropriate were used to generate design guideline criteria presented in section 4.1.2. This criteria simplifies the analysis procedures for the PRR designs.

TOTAL NUMBER OF SET COMPUTATION SHEETS 73FINISHED BY B. RanganathanCHECKED BY Ashok Patel

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DATE	<u>1-13-82</u>	<u>1-20-82</u>	<u>1-22-82</u>	

REVISION 1 STARTED DATE

BY

8205030385



CALCULATION SUMMARY & REFERENCE SHEET

PROJECT TITLE PSNH-SEABROOK UNITS 1 & 2 DISCIPLINE PSG

SYSTEM REACTOR COOLANT -49 SYSTEM

SUBJECT PIPE WHIP RESTRAINTS IN THE CONTAINMENT

DESIGN CLASSIFICATION STRUCTURAL (NOT SAFETY RELATED)

CALC. SET NO.

PRELIM.

FINAL

9763-B-04-00-12

VOID

SHEET OF

J.O. 9763-006

REV

COMP. BY

CHK'D BY

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DATE

1-13-82

DATE

1-13-82

DATE

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SUMMARY/CONCLUSIONS

See Section 2.0 and 3.0

REFERENCES: (SPECIFICATIONS, DRAWINGS, CODES, CALCULATION SETS, TEXTS, REPORTS, COMPUTER DATA
PSAR ETC.)

See Section 5.0

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1.0 INTRODUCTION

The function of pipe rupture restraints (PRR's) are to protect safety related systems, components and structures from the effect of postulated pipe breaks. This is accomplished by having the PRR's control and limit the motions of the ruptured pipe while allowing thermal expansion and seismic movements to occur when the pipes are in their operating modes. The restraints listed in section 1.1 of this report are located in the containment and are welded to the embedments.

The PRR's PW-49-1 and PW-49-2 consist of energy absorbing crush pads to absorb the postulated pipe break loads for line RC-49-1-14. U-Bolts are used for PRR PW-49-1 to resist rebound loads. PRR's PW-49-4b, PW-49-3a and PW-49-4a are designed to resist postulated break of line RC-49-1-14. Also U-bolts are provided for PRR's PW-49-4b and PW-49-4a to resist rebound loads. PRR PW-49-4b also serves as a pipe support. U-bolts are provided for PW-49-3b to resist postulated pipe break loads.

The purpose of this report is to show by analysis that these restraints will perform their intended functions without exceeding the stress limits set forth in section 4.1.2.

1.1 PRR LIST

SERIAL NO.	PRR NO.	DRAWING NUMBER	
1	PW-49-1	9763-F-104028	Rev. 3
2	PW-49-2	9763-F-104028	Rev. 3
3	PW-49-4b	9763-F-104028	Rev. 3
4	PW-49-3a	9763-F-104029	Rev. 6
5	PW-49-4a	9763-F-104029	Rev. 6
6	PW-49-3b	9763-F-104030	Rev. 4

2.0 SUMMARY OF RESULTS

The PRR structures were analyzed to the criteria specified in section 4.1.2. All members of the structures as well as connections were within allowable stress limits. Plastic deformation of members and U-bolts for PRR's PW-49-3a, 4a and 4b is less than 50% of the minimum ultimate uniform strain. Also deformation of crush pad is less than 75% of the crush pad core height.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-1

DESCRIPTION	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
W14x145 (WITH STIFFNERS)	COMPRESSIVE	27	16.77	32.4	-
STIFFNERS FOR PC. W14x145	COMRESSIVE	27	15.88	21.09	-
MC18x45.8 WITH STIFFNERS	COMPRESSIVE	27	14.68	32.4	-
STIFFNERS FOR MC18x45.8	COMPRESSIVE	28	13.44	22.19	-
R 1/2"x22"x28"	BENDING	26	8.16	32.4	-
U-BOLT	TENSION	26	18.15	32.4	-
<u>WELDS</u>					
5/16" FILLET TO STIFFNER OF MC18	-	28	15.75	32.4	-
1/4" FILLET TO WEB OF W14 & MC18	-	28	30.09	32.4	-

1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-2

DESCRIPTION (3)	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
W 14 x 109	COMPRESSIVE	33	12.1	32.4	-
R - COLUMN CAP	BENDING	33	29.47	32.4	-
W 14 x 283	TENSION		3.58	32.4	} 0.64
↓	BENDING	41	17.23	32.4	
	SHEAR		14.91	19.4	
CRUSH PAD	DEFLECTION	32	1.389 INCH	3.5 INCH.	-
<u>WELDS</u>					
5/8" FILLET BET. W14x283 & L8x4 (JT. B*)	-	38	21.0	32.4	-
1/2" FILLET BET. W14x283 AND BEAM W14x283 (JT. B*)	-	38	24.6	32.4	-
3/4" FILLET BET. W14 & BEAM W14x283 (JT. D*)	-	39	21.5	32.4	-
3/4" FILLET BET. W14 & EMB. R 148 (JT. A*)	-	40	20.7	32.4	-
3/4" FILLET BET. W14 & EMB. R 147 (JT. E*)	-	40	22.5	32.4	-

NOTES:

1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.
3. See sheet no. 31 for joint locations.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-4b

DESCRIPTION	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
U-BOLT	STRAIN	46	0.034 INCHES (Elongation)	0.225 INCHES (Elongation)	-
W14 x 283 (FLANGE)	BENDING	46	23.3	32.4	-
1/2 STIFFENER PL	TENSION	46	7.31	32.4	-
PL W14 x 283 (WEB)	COMPRESSION	47	4.5	32.4	-
<u>WELD</u>					
3/8 FILLET TO 1/2 STIFFENER	-	46	6.89	32.4	-
3/8 AND 1/2 FILLET TO W14 x 283 & EMB. PL	-	47	16.64	32.4	-
3/8 FILLET TO WEB OF W14	-	47	4.53	32.4	-

1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-3a

DESCRIPTION	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
W14 X 43	STRAIN	54	0.012 INCHES (Elongation)	0.095 INCHES (Elongation)	-
CAP R FOR W14 X 43	BENDING	55	17.78	32.4	-
STIFFNER R BELOW CAP R	COMPRESSIVE	55	28.8	32.4	-
<u>WELD</u>					
5/16" FILLET TO STIFFNERS	-	55	32.4	32.4	-
3/8" FILLET TO BASE R	-	56	16.4	32.4	-

1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-4a

DESCRIPTION	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
WEB OF W12X65	STRAIN	61	0.031 INCH	0.1 INCH	-
WEB OF W12X65 & WEB OF WT7	COMPRESSION	61	20.32	22.29	-
U-BOLT	TENSION	63	22.85	32.4	-
FLANGE OF WT7X141.5	BENDING	63	14.96	32.4	-
WEB OF WT7X141.5	TENSION	63	4.29	32.4	-
<u>WELDS</u>					
$\frac{3}{16}$ & $\frac{3}{8}$ FILLET BET. WEB OF W12 AND EMB.R	-	62	31.9	32.4	-
$\frac{1}{2}$ FILLET BET. PC W12 AND EMB.R	-	62	19.8	32.4	-
$\frac{3}{8}$ FILLET BET. WT7 & EMB.R	-	63	3.31	32.4	-

1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.

2.1 TABLE OF ACTUAL V/S ALLOWABLE STRESS

PRR PW-49-3b

DESCRIPTION (3)	STRESS TYPE	SHEET NO	ACTUAL STRESS f (ksi)	ALLOWABLES	
				STRESS F(ksi) (1)	STRESS RATIO ≤ 1.0 (2)
W14x61	COMPRESSIVE	68	30.95	32.4	-
CAP R TO W14x61	BENDING	67	21.18	32.4	-
3/4" STIFF. BET. W14x61 AND W14x283	COMPRESSIVE	68	20.76	32.4	-
WEB OF PC. W14x283	COMPRESSIVE	72	17.99	32.4	-
FLANGE OF PC. W14x283	BENDING	68	23.27	32.4	-
1/2" STIFF. TO PC. W14x283	TENSION	71	7.31	32.4	-
U-BOLT	STRAIN	70	0.0039 INCH	0.225 INCH	-
<u>WELDS</u>					
3/8" FILLET BET. CAP R & W14x61	-	67	32.3	32.4	-
3/8" FILLET BET. W14x61 & W14x283	-	67	32.4	32.4	-
3/8" FILLET BET. 3/4" STIF. W14 & PC. W14	-	68	29.36	32.4	-
3/8" & 1/2" FILLET BET. WEB OF PC. W14 & FLANGE OF W14 AND EMB. R	-	68	22.87	32.4	-
3/8" & 1/2" FILLET BET. W14x283 & EMB. R	-	68	18.62	32.4	-
3/8" FILLET FOR 1/2" STIFF.	-	71	6.89	32.4	-

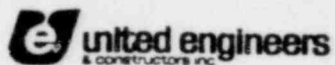
1. See section 4.1.2 for allowable stress limits.
2. See section 4.1.2.2 for equations to determine stress ratios.

2.2

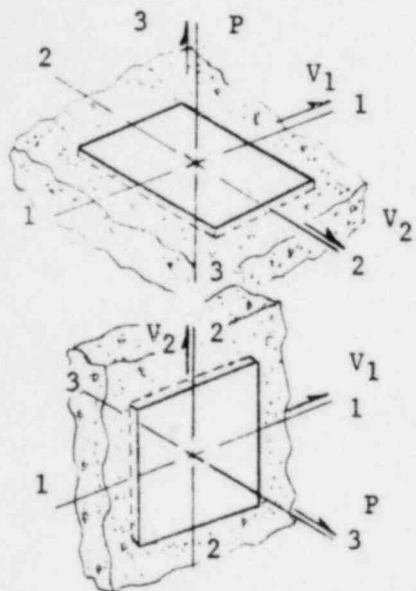
EMBEDMENT LOADS

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH - Seabrook Station UNIT/S 1 & 2SUBJECT PRR DESIGN AND ANALYSIS

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	AJP	BRL
FINAL	9763-8-04-00-12		DATE 1-11-82	DATE 1-11-82
VOID				
SHEET 11	OF		DATE	DATE
JO 9763.006				

EMBEDMENT LOADS

HORIZ = H

VERT. = V

SYSTEM: REACTOR COOLANT

LINE: RC-49-1-14

LOCATION: CONTAINMENT

SIGN CONVENTION:

FORCES: POSITIVE AS SHOWN

MOMENTS: FOLLOW RIGHT HAND RULE

PRR NO.	EMBEDMENT PLATE			LOADS ABOUT CENTERLINE OF EMBEDMENT PLATE					
				KIPS			IN - KIPS		
	NO.	H/V	DWG. NO.	P	V ₁	V ₂	M _T	M ₁	M ₂
PW-49-1	146	V	104028	-339	-	82	-	1536	-
PW-49-2	147	H		320	-	298	-	-8745	-
PW-49-2	148	V		90	-	320	-	6308	-
PW-49-4b	153	H		354	-	-	-	-	-
PW-49-3a	149	V	104029	-386	239	-	-	-	-
PW-49-4a	152	V		55.4 -504	-	-	-	-	-
PW-49-3b	150	H	104030	354 -554	-	-	-	-	-

3.0 CONCLUSIONS

The PRR'S listed in section 1.1 will perform their intended functions of protecting safety related systems, components and structures from the effects of postulated pipe breaks. The PRR designs are adequate to withstand the applied loads given in section 4.1.3 and meet the stress limits specified in section 4.1.2.

4.0 ANALYSIS

4.1 DESIGN CRITERIA

Pipe rupture restraints must be capable of withstanding dynamic loads resulting from pipe rupture and restrain the motion of the ruptured pipe. In applying plastic deformation design, maximum strain in the members is limited to 50% of the minimum ultimate uniform strain.

Maximum deformation of crush pads must be limited to 75% of the crush pad core height. For limits of allowable stress, see section 4.1.2.

4.1.1 MATERIAL AND SECTION PROPERTIES

4.1.1.1 MATERIAL

Tabulated below are the materials and properties used for the PRR designs taken at 100° F ambient temperature inside the containment.

MATERIAL	MECHANICAL PROPERTIES (KSI)		
	Su	Sy	E
ASTM A - 36	58	36	27.9×10^3

4.1.1.2 SECTION PROPERTIES:

Standard sections are used for the PRR structure. See reference 1 for section properties of the standard sections.

4.1.2 Allowable Stresses for Elastic Restraints

All symbols used in the following table are according to ASME III article XVIII-1000 (page #331) except symbols with hyphen (e.g. F') are used to define allowable stresses for faulted condition.

4.1.2.1 TABLE OF ALLOWABLE STRESSES

ITEM		STRESS TYPE	ALLOWABLE STRESS	COMMENTS
STRUCTURAL STEEL		<ul style="list-style-type: none"> - Tension - Shear - Bending - Compression 	$F't = 0.90 S_y$ $F'v = 0.55 S_y$ $F'b = 0.90 S_y$ $F'a = 0.66 F_a$	See Section 4.1.2.2 for F_a
WELD	FULL PENETRATION	ALL	Same As Base Metal	
	PARTIAL PENETRATION	<ul style="list-style-type: none"> - Compression normal to weld axis 	Same As Base Metal	See note (1)
		<ul style="list-style-type: none"> - Tension & Compression parallel to weld axis. 		
		<ul style="list-style-type: none"> - Shear - Tension normal to weld axis. 	$F'w = 1.5 f_w$	
	FILLET	<ul style="list-style-type: none"> - Tension & Compression to weld axis. - Shear 	Same As Base Metal $F'w = 1.5 f_w$	

Note: (1) $f_w = 0.3 \times$ normal tensile strength of weld material.

4.1.2.2 COMBINED STRESSES

Axial Compression and Bending

For members subjected to both axial compression and bending, stresses shall be proportioned to satisfy the following equation:

$$\frac{f_a}{F'_a} + \frac{f_b}{F'_b} \leq 1.0$$

$$F'_a = 0.66 F_a$$

Where

$$F_a = \left[1 - \frac{(Kl/r)^2}{2C_a^2} \right] S, \quad \text{for } Kl/r > 25$$

and

$$C_a = \sqrt{\frac{2\pi^2 E}{S_y}} \leq Kl/r \quad - \text{ see note (1)}$$

$$\text{also } F'_a = 0.90 S, \quad \text{for } Kl/r \leq 25$$

Axial Tension and Bending

Members subjected to both axial tension and bending stresses shall be proportioned to satisfy the following equation:

$$\frac{f_t}{F'_t} + \frac{f_b}{F'_b} \leq 1.0$$

Note: (1) for $C_c > Kl/r$, see ASME section XVII - 2213.2 to determine F_a

4.1.2.3 ALLOWABLE STRESS VALUES

Allowable stress values are calculated with reference to section 4.2.1. Equations used to calculate these values are according to section 4.2.2. Following are the values of allowable stresses for ASTM A-36 steel and E70 XX electrode for weld.

STRUCTURAL STEEL

Tension	-	$F't = 0.90 S_y = 32.4 \text{ ksi}$
Shear	-	$F'v = 0.55 S_y = 19.8 \text{ ksi}$
Bending	-	$F'b = 0.90 S_y = 32.4 \text{ ksi}$
Compression	-	$F'a = 0.66 F_a$ See section 4.2.2.2 for determination of F_a

where $S_y = 36 \text{ ksi}$

WELD

$$\begin{aligned} F'w &= 1.5 f_w \\ &= 1.5 \times (0.3 \times 72.0 \text{ ksi}) = 32.4 \text{ ksi} \end{aligned}$$

4.1.3 LOAD CRITERIA

From NRC postulates break criteria, only one break at a time is postulated to occur. The PRR's shown in drawing no. 9763-F-104028, 104029 and 104030 are designed to resist the pipe break loads given in reference 5 .

PRR's PW-49-1 and PW-49-2 are designed to absorb energy released due to a postulated pipe break. U-bolts used for PRR PW-49-1 are designed for 20% of blowdown force ($F_b = 277$ kips).

PRR's PW-49-3a, -4a and -4b are designed to withstand postulated pipe break load of 454 kips, 356 kips and 354 kips respectively. PRR PW -49-3b is designed for 554 kips load (+ y direction) and 354 kips load (- y direction).

4.2 DETAILED STRESS ANALYSIS

4.2.1 ANALYSIS OF PRR PW-49-1

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1 & 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM		0	ER	ARUP
FINAL	<u>-B-04-00-12</u>			
VOID				
SHEET <u>22</u> OF			DATE <u>4.22.81</u>	DATE <u>12.11.81</u>
JO 9763 006			DATE	DATE

104 028

PW-49-1

LINE RC-49-1-14'

DATABLOW DOWN FORCE, F_B

= 277 KIPS

DIRECTION OF BLOW DOWN

N 68°W

DATA POINT

60

COLD GAP IN HORIZONTAL DIRECTION

1 1/4"

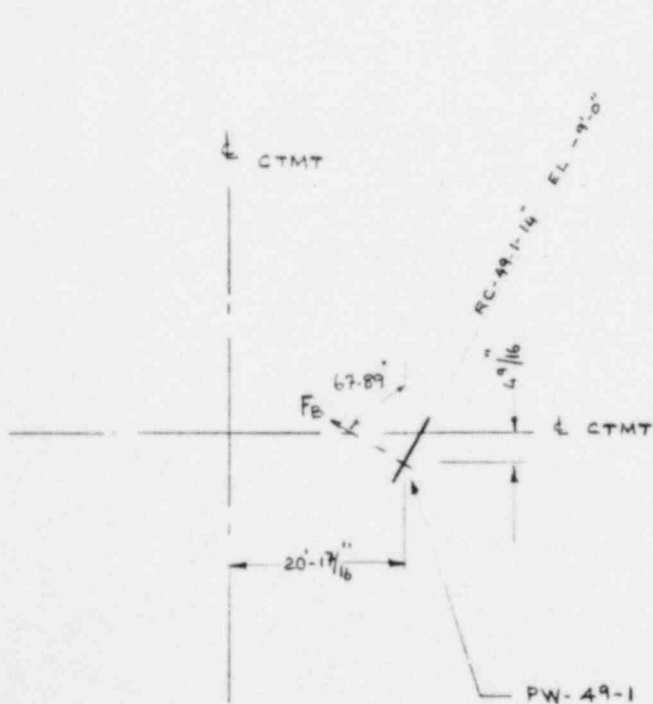
Y COLD GAP = - 13/16

HOT GAP IN HORIZONTAL DIRECTION

3/16"

Y HOT GAP = - 11/16

LOAD ON U-BOLT

20% F_B = 55.4 KIPSLOCATION PLAN

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

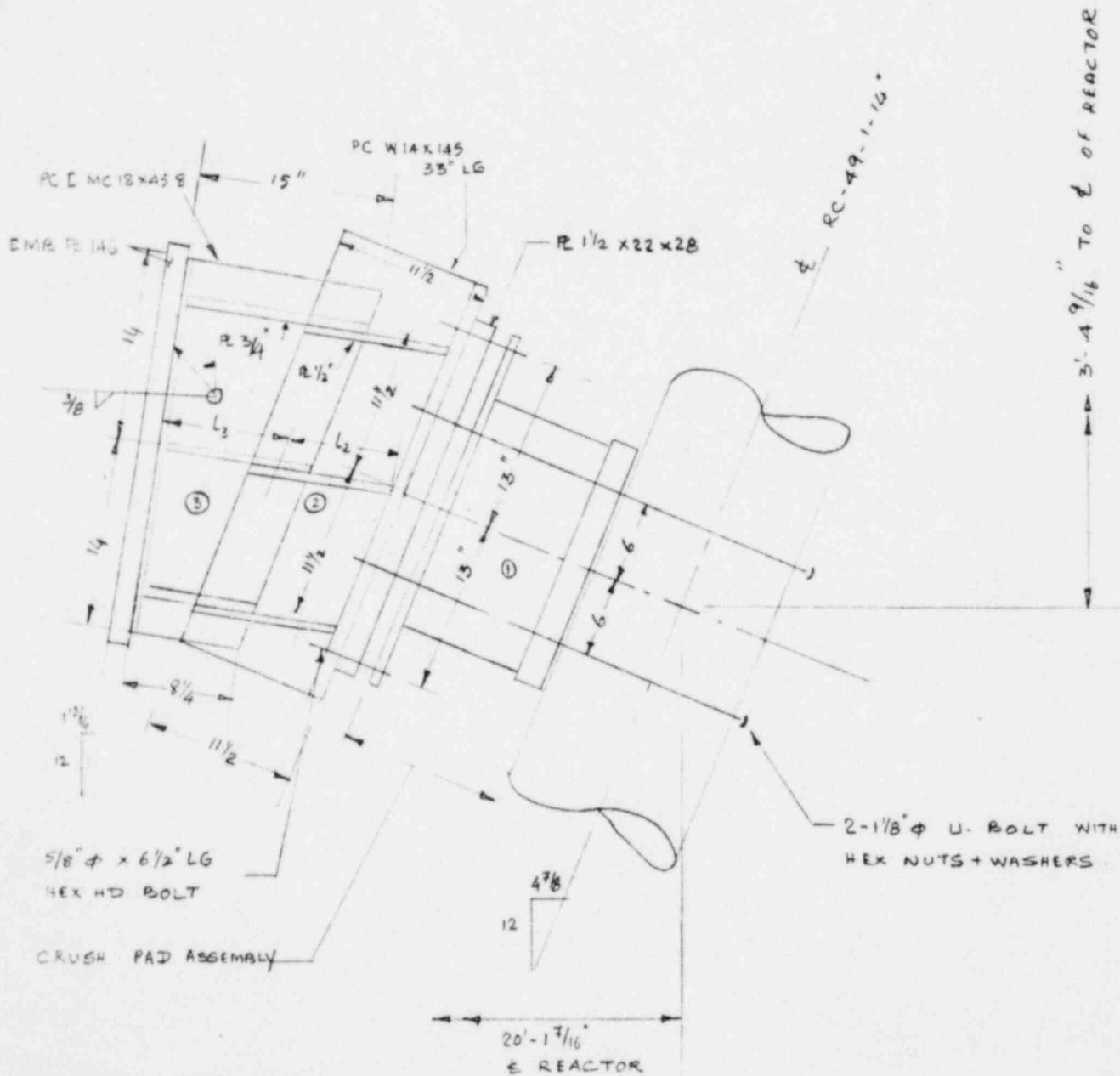
CALC SET NO.		REV	COMP BY	CHKD BY
PRELIM		0	RE	ARUP
FINAL	-B-04-00-12		DATE 11.24.81	DATE 12.11.81
VOID				
SHEET 23 OF			DATE	DATE
JO 9763 006				

104 028

PW-49-1

LINE

RC-49-1-16



1. CRUSH PAD
2. W14x145 + STIFFENER PLATES
3. MC 18x45.8 + STIFF PLATES

PLAN OF PW-49-1

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 182

STRUCTURAL CALCOR SITE WHIP RESTRAINT

CALC. SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	ER	ARUP
FINAL	-B-04-00-12		DATE	DATE
VOID			6-23-81	12-11-81
SHEET 24 OF			DATE	DATE
JO. 9763.006				

104028

PW-49-1

LINE RC-49-1-14"

CALCULATION FOR CRUSH PADBLOW DOWN LOAD, $F_B = 277$ KIPSHOT GAP, $\delta_H = 1.0625$ INLET CRUSH PAD HEIGHT, $H = 9$ IN

ALLOWED DEFORMATION OF CRUSH PAD = 70% OF $H = 0.7 \times 9 = 6.3$ IN
 ELASTIC DEFORMATION = 0.25" (CONST) DATA FROM MANUFACTURER

$$F_B (\delta_H + \delta) = R_P \left(\frac{\delta_E}{2} + \delta_P \right)$$

$$277 (1.0625 + 6.3) = R_P (6.3 - \frac{0.25}{2})$$

 δ = TOTAL DEFORMATION δ_E = ELASTIC " δ_P = PLASTIC " $\delta_P = \delta - \delta_E$ THIS GIVES $R_P = 330.26 \approx 331$ KIPS. = R_m

FOR 12 GAUGE CRUSH PAD RESISTANCE = 1.952 KSI

REQD. CROSS SECTION = $331 / 1.952 = 169.6$ SQ INCHOOSE 18×9.9 & 6×3 and 3.3×3

$$A_c = 178.2 \text{ SQ IN}$$

CAPACITY = $178.2 \times 1.952 = 348$ KIPS. = R_c

DESIGN LOAD ON RESTRAINT = 348 KIPS.

NAME OF COMPANY **PSNH—SEABROOK STATION** UNIT/S **12**

 STRUCTURAL CALCS—PIPE WIND RESTRAINT
 SUBJECT

PRELIM	REV	DATE	CHKD BY
FINAL	0	12.14.81	ARIP
VOID			
SHEET 26 OF	1	DATE	DATE
JO 274		6.2.2.02	42-22.82

104022

PW-49-1

LINE RC-49-1-14'

$$\theta_1 = \tan^{-1} \frac{1.12/6}{12} = 8.5^\circ$$

$$\theta_2 = \tan^{-1} \frac{4.7/8}{12} = 22.1^\circ$$

$$\theta_3 = \theta_2 - \theta_1 = 13.6^\circ$$

$$L_2 = (11' - 4.5/2) / \cos \theta_3 = 9.51 \text{ IN}$$

$$L_3 = \frac{12 + 8.35}{2} - \frac{4.5}{2} = 9.375 \text{ IN}$$

$$A_2 = 28 \times 0.68 + (4 \times 0.5) 0.5 \times 3 = 29.34 \text{ SQ IN}$$

$$A_3 = 28 \times 0.5 \times 2 + 6 \times (4 - 0.5) 0.75 = 43.75 \text{ SQ IN}$$

$$\text{U-BOLT LOAD} = 20\% \text{ FL} = 0.2 \times 277 = 55.4 \text{ KIP}$$

$$\text{LOAD PER LEG} = 13.85 \text{ KIPS; TENSILE AREA OF } 1/8" \text{ d BOLT} = 0.763 \text{ SQ IN}$$

$$\text{STRESS} = 13.85 / 0.763 = 18.15 \text{ KSI} < 32.4 \text{ O.K.}$$

$$\text{CHECK } R \text{ } 1/2 \times 22 \times 1/8 \text{ FOR BENDING DUE TO U-BOLT LOAD}$$

$$\text{LOAD PER LEG} = 55.4 / 4 = 13.85$$

$$\text{C/G OF LEGS} = 16.1875 \text{ IN}$$

$$\text{WIDTH OF FLANGE OF } W14 \times 145 \text{ (CUT TO } 10" \text{ WIDTH)} = 10"$$

$$\text{OVERHANG} = (16.1875 - 10) / 2 = 3.09375 \text{ IN}$$

$$\text{MOMENT} = (2 \times 13.85) 3.09375 = 85.7 \text{ KIN}$$

$$S = 21.7 \times 10^3 / 6 = 10.5 \text{ IN}^2$$

$$\text{STRESS} = 85.7 / 10.5 = 8.16 \text{ KSI} < 32.4 \text{ O.K.}$$

$$\text{SHEAR} = 2 \times 13.85 = 27.7 \text{ K}$$

$$\text{SHEAR STRESS} = 27.7 / (28 \times 1.5) = 0.66 \text{ KSI}$$

WELD

$$1/4" \text{ WFLD ALL POINTS } W14 \times 145 \text{ AND } R \text{ } 1/2 \times 28 \times 22.$$

$$A_W = (28 + 15.6) 2 = 87 \text{ IN}$$

$$\text{CAPACITY} = 87 \times 0.75 = 0.707 \times 32.4 = 498 \text{ K} > 55.4 \text{ O.K.}$$

$$\text{STRESS} = 55.4 / (2 \times 0.75 \times 0.707) = 50.6 \text{ KSI} < 32.4 \text{ O.K.}$$



NOTE - AS PER AWS D1.1, 5/16 MIN GIZE FILLET WELD REQUIRED. MIN GIZE SHOWN ON DETAIL DWG.

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1.2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	E.X.	ARUP
FINAL	<u>-B-04-00-12</u>		DATE 11-24-81	DATE 12-14-81
VOID				
SHEET <u>27</u> OF			DATE	DATE
JO <u>9762-006</u>				

104028

PW-49-1

LINE

KC-49-1-14"

PRINCIPAL LOAD DUE TO BLOW DOWNDIRECTION OF APPLICATION OF LOAD Q_2 TO HORIZONTAL = 22.11° DIRECTION OF RESISTANCE Q_1 TO HORIZONTAL = 8.59° ANGLE BET. THEM: $Q_2 - Q_1 = Q_3 = 13.52^\circ$

LENGTH OF RESISTANCE MEMBERS = $L_2 + L_3$
 $= 9.51 + 9.375$
 $= 18.885$ IN

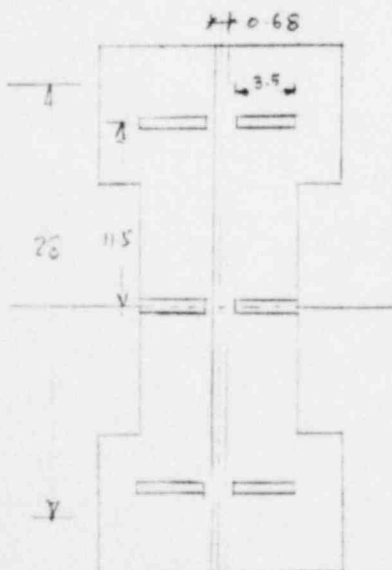
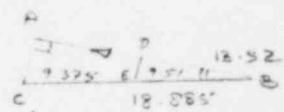
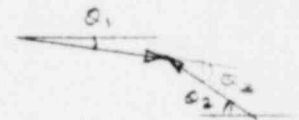
CHECK PC MC 18X45.5 WITH STIFF

AC = $18.885 \sin 13.52 = 4.415$ IN.

P = 348 K

PC = $388 \times 4.415 = 1526$ K IN

$$\frac{P}{A} + \frac{M}{S} = \frac{348}{43.75} + \frac{1526}{229.85} = 14.64 \text{ KSI}$$

STIFF $\frac{348}{43.75} + \frac{1526 \times 11.5}{3217.96} = 13.40$ KSI (REF SKETCH →)DE = $9.51 \sin 13.52 = 2.22$ IN } FORCES ATM = $348 \times 2.22 = 773$ K IN } TOP

TOP W 14X145 + STIFF.

$$L_{EFF} = 28 / \cos 13.52 = 28.8288$$

$$A_{EFF} = 28.0 \times 0.68 + 6 \times 3.5 \times 0.5$$

$$= 29.54 \text{ IN}^2$$

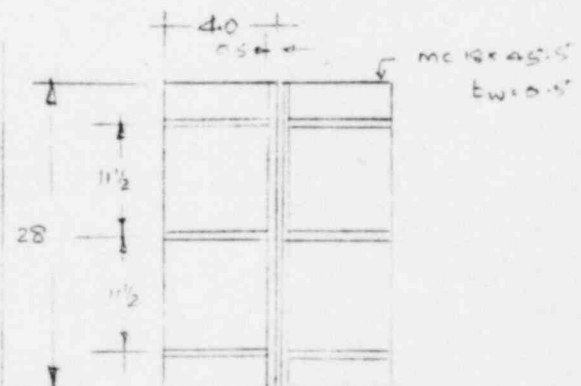
$$I = \frac{0.68 \times 28^3}{12} + (3.5 \times 0.5) 11.5^2 \times 4$$

$$= 2169.7$$

$$S = 2169.7 / 14 = 154.97$$

$$\frac{P}{A} + \frac{M}{S} = \frac{348}{29.54} + \frac{773}{154.97}$$

$$= 16.77 \text{ KSI}$$



$$A = 0.5 \times 28 \times 2 + (4.05) \times 0.75 \times 6$$

$$= 43.75 \text{ SQ IN}$$

$$I = \frac{0.5 \times 28^3}{12} \times 2 + 2.625 \times 11.5^2 \times 4$$

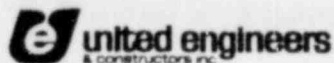
$$= 3217.96 \text{ IN}^4$$

$$S = 3217.96 / 14 = 229.85 \text{ IN}^3$$

WELD BET MC 18X45.5 & STIFFENERSTRESS AT LEVEL OF STIFFENER = $\frac{348}{29.54} + \frac{773 \times 11.5}{2169.7} = 15.88$ KSI (FOR ALLOWABLE STRESS NEXT PAGE)LOAD ON STIFFENER = $15.88 \times 0.5 \times 28 = 27.8$ KWELD LENGTH = $4.5 + 3.5 = 8$ INWELD STRESS = $27.8 / 8 = 3.48$ KSI

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BZ	AKUP
FINAL	-B-04-00-12			
VOID				
SHEET 28 OF			DATE 11.24.87	DATE 12.14.81
JO 9763-006			DATE	DATE

104028 PW-49-1 LINE RC-49-1-10"

$$\text{WELD PROVIDED} = 5/16 = 0.3125$$

$$\text{STRESS IN WELD} = \frac{3.48}{0.3125 \times 0.707} = 15.75 \text{ KSI} < 32.4 \text{ O.K.}$$

ALL OTHER WELDS O.K. AS THEY ARE EITHER LARGER AND/OR OF GREATER LENGTH.

ALL MEMBERS O.K.
ALL WELDS O.K.STIFFENER IN W14X145

$$\text{CLEAR LENGTH} = (11.5 - 1.09 - 4.5) / \cos 13.52 = 6.08 \text{ IN}$$

$$J_y = 3.5 \times 0.5^3 / 12 = 0.03646 \text{ IN}^4$$

$$A = 0.5 \times 3.5 = 1.75 \text{ IN}^2$$

$$\sqrt{I_y / A} = 0.104 \text{ IN}$$

$$K l / r_y = 1 \times 6.08 / 0.104 = 42.22$$

$$\text{ALLOWABLE STRESS IN COMP} = \left[1 - \frac{42.22^2}{2 \times 126.1^2} \right] 36 \times 0.66 = 21.09 \text{ KSI}$$

$$> 15.88 \text{ KSI O.K.}$$

STIFFENER IN MC18X45.8 0.75X3.5

$$\text{CLEAR LENGTH} = 15 - 4.5 - 0.625 = 9.875 \text{ IN}$$

$$I_y = 0.75^3 \times 3.5 / 12 = 0.123 \text{ IN}^4$$

$$A = 0.75 \times 3.5 = 2.625 \text{ IN}^2$$

$$r_y = (0.123 / 2.625)^{1/2} = 0.216$$

$$K l / r_y = 1 \times 9.875 / 0.216 = 45.7$$

$$F_{AC} = 0.66 \times 36 \left[1 - \frac{45.7^2}{2 \times 126.1^2} \right] = 22.19 \text{ KSI} > 13.44 \text{ O.K.}$$

WELD 1/4" ON 2 SIDES OF WEB OF MC18X45.8 AND WEB PC W14X145

$$\text{STRESS IN WEB} = 14.65$$

$$\text{FORCE PER INCH} = 14.65 \times 0.68 = 10.63$$

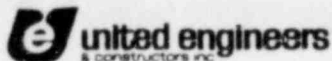
$$\text{FORCE ON WELD} = 10.63 / 2 = 5.32 \text{ KLI}$$

$$\text{WELD STRESS} = 5.32 / (0.707 \times 32.4) = 30.09 \text{ KSI}$$

4.2.2 ANALYSIS OF PRR PW-49-2

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY: PSNH—SEABROOK STATION UNIT/S 1 & 2STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	RL	ASP
FINAL	13-04-00-12			
VOID				
SHEET 30 OF			DATE 2-25-81	DATE 11-24-81
JO 9763.006			DATE	DATE

104 028

LINE RC-49-1-14

RESTRAINT - PW-49.2

BLOW DOWN FORCE 277 KIPS

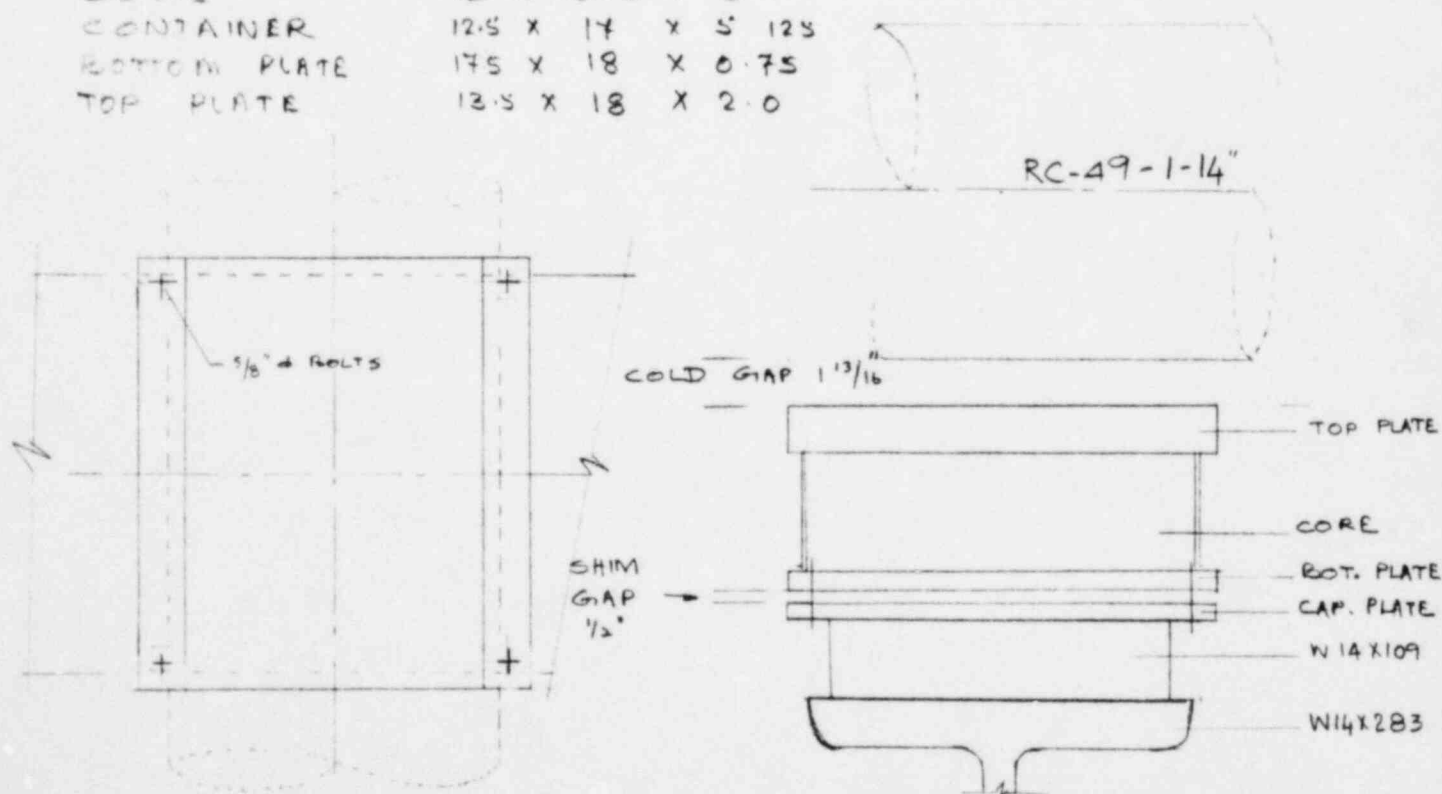
GAPS

		COLD	HOT
VERTICAL	y	-1 1/16	-15/16
HORIZONTAL	b	1 13/16	3/8

CRUSH PAD

ROBERTSON CRUSH PAD 12 GAUGE

CORE	12 x 16.5 x 5
CONTAINER	12.5 x 14 x 5 12.5
BOTTOM PLATE	17.5 x 18 x 0.75
TOP PLATE	13.5 x 18 x 2.0



GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1&2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ASP
FINAL	-8-04-00-12			
VOID				
SHEET 32 OF			DATE 2.25.81	DATE 11.24.81
JO 9763.006			DATE	DATE

104 028

PW-49-2

FB: 277 K

 $\sigma = 0.375''$ CRUSH PAD (REF DWG 104048)CORE $h = 5''$ $w = 12''$ $l = 16.5''$ $A_c = 12 \times 16.5 = 198 \text{ sq in}$ BLOW DOWN FORCE $F_B = 277 \text{ KIPE}$
HOT GAP $\sigma = 0.375''$ $\delta_m = \text{MAX DEFORMATION OF CRUSH PAD ALLOWED} = 0.7 \times 5 = 3.5''$ $\delta_e = \text{ELASTIC DEFORMATION OF CRUSH PAD} = 0.25''$ FROM EXPERIMENT CONSTANT.

WORK EQUATION - EXTERNAL WORK = INTERNAL STRAIN ENERGY

$$277 (0.375 + 3.5) = R_m (3.5 - 0.25/2)$$

$$R_m = 318.04 \text{ K}$$

 R_m - CRUSH PAD RESISTANCE.FOR ROBERTSON 12 GAUGE CRUSH PAD RESISTANCE / CAPACITY PER SQ INCH (MANUFACTURER'S DATA) $Q_c = 1.952 \text{ K}$

$$\therefore \text{TOTAL RESISTANCE CAPACITY} \left. \begin{array}{l} R_c = Q_c A_c \\ \text{DEFORMATION FOR } R_c = 386.5 \text{ K} \end{array} \right\} = 1.952 \times 198 = 386.5 \text{ K} = R_c$$

DEFORMATION FOR $R_c = 386.5 \text{ K}$

$$277 (0.375 + \delta_m) = 386.5 (\delta_m - 0.25/2)$$

$$\text{SOLVING } \delta_m = 1.389''$$

$$\% \text{ DEFORMATION} = \frac{1.389}{5} \times 100 = 28\% < 0.7 H$$

$$\therefore \text{CORE DIMENSIONS} = 12 \times 16.5 \quad h = 5''$$

$$\text{DESIGN LOAD} = R_c = 386.5 \approx 387 \text{ KIPE}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY: PSNH—SEABROOK STATION UNIT/S: 1 & 2SUBJECT: STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	AP
FINAL	-8-04-00-12			
VOID				
SHEET	33 OF		DATE	DATE
JO	9763.006		2.26.87	11-24-81
			DATE	DATE

104 028

PW-49.2

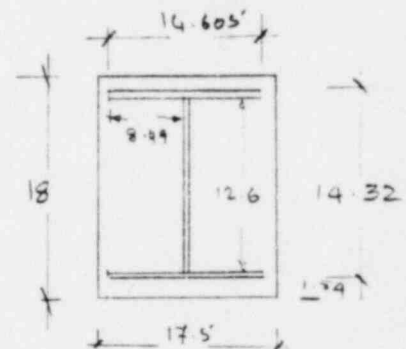
LINE RC-49.1-14"

STUB COLUMN W14X109 $A_c = 32.0 \text{ sq in}$ $r_y = 3.73 \text{ in}$ LOAD = 387 KIPS. AREA OF CROSS SECTION, $A_c = 32.0 \text{ sq in}$.COMP STRESS = $387/32 = 12.1 \text{ ksi}$ HT OF COL = $21 - (7 + 1^{13}/16 + 20 + 5.125 + 0.75 + 0.75) = 3.5625 \text{ in}$ $Kr/r = 2 \times 3.5625/3.73 = 1.91 < 25$ $\therefore F_{ac} = 0.9 \times 36 = 32.4 \text{ ksi} > 12.1 \text{ O.K.}$ CAP PLATE (REF SEC 104 028 G)

SIZE 0.75 X 17.5 X 18.

$$\text{LOADING} = \frac{387}{17.5 \times 18} = 1.228 \text{ ksi}$$

2 OPPOSITE SIDES SIMPLY SUPPORTED
 1 " FIXED
 1 " FREE



$$t_f = 0.86$$

$$t_w = 0.525$$

$$a = 12.6 \quad b = 8.49; \quad a/b = 1.484 \approx 1.5$$

$$\text{MAX STRESS} = (1.282 \times 1.228 \times 8.49^2) / 0.75^2 = 202 \text{ ksi} \quad \text{V. HIGH}$$

INTRODUCE AN ADDITIONAL PLATE AT CENTRE
 BOUNDARY CONDITIONS - 2 EDGES FIXED, 1 EDGE S. SUPPORTED
 AND 1 FREE.

THIS SIMPLIFIED TO - 2 OPP. EDGES S. SUPPORTED, 1 FIXED
 AND 1 FREE.

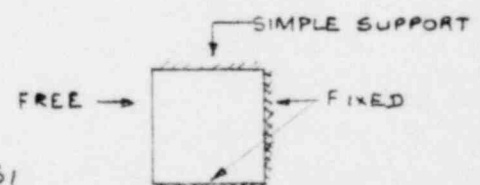
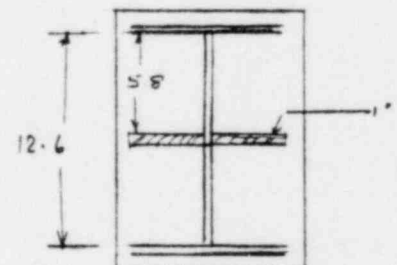
$$a/b = \frac{5.8}{8.49} = 0.683 \quad \text{* (REF #3 FORMULAE FOR STRESS & STRAIN BY ROARK - PP 391)}$$

$$P_1^* = 0.225; \quad P_2^* = 0.333$$

$$\text{MAX STRESS} = 0.333 \times 1.228 \times 8.49^2 / 0.75^2$$

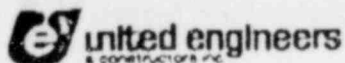
$$= 52.4 \text{ ksi}$$

FOR 1" THICK CAP PLATE STRESS = 29.47 ksi
 (1" THICK PLATE IS USED) O.K.



GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH--SEABROOK STATION UNIT/S 192SUBJECT STRUCTURAL CALCS--PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHKD BY
PRELIM		0	EL	ASP
FINAL	-8-04-00-12		DATE 7-26-81	DATE 11-24-81
VOID				
SHEET	34 OF	1	EL	ASP
JO	9763.006		DATE 11-22-82	DATE 4-22-82

104 028W14X109 $A_c = 32.5 \text{ in}^2$ $d = 14.32' \text{ } l_w = 5.52'$ $b_f = 14.605' \text{ } t_f = 0.707'$ CHECK WELDS OF CAP PLATE AND STIFFENER PLATES

WELD BET. 1" R & W14X109

$$A_w = 14.605 \times 2 + 4 \times 7.04 \times 2 + 0 \times 5.8 = 108.73 \text{ in}$$

$$\text{FOR } 3/16" \text{ WELD, STRESS} = 387 / 108.73 = 3.56 \text{ KLI}$$

REDUCE WELD LENGTH

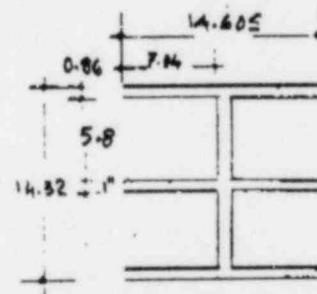
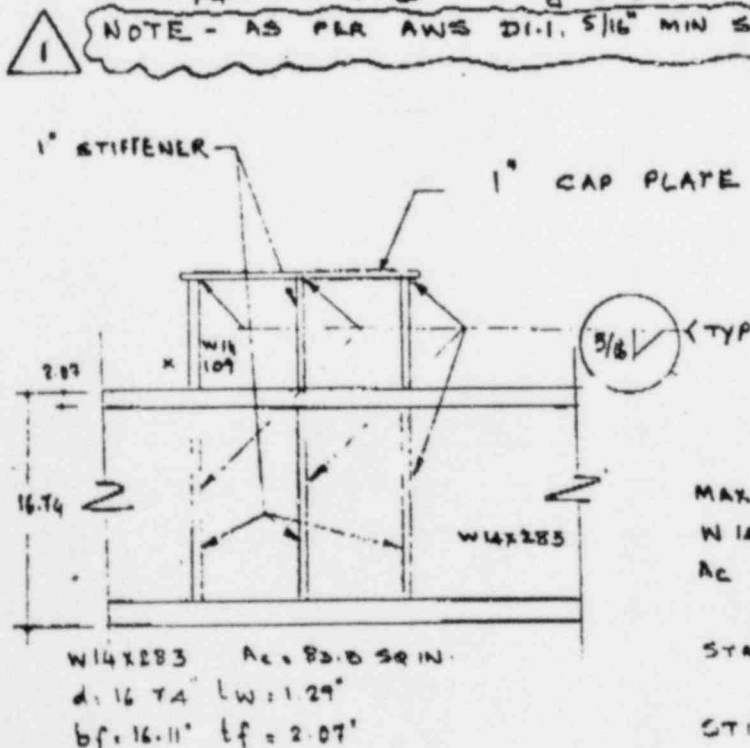
$$2 \times 14.605 + 4 \times 5.8 + 4 \times 7.04 = 80.57 \text{ in}$$

$$\text{STRESS} = 387 / 80.57 = 4.80 \text{ KLI}$$

$$3/16" \text{ WELD} = \frac{8}{16} \times 0.707 \times 32.4 = 4.3 \text{ KLI}$$

$$\text{FOR } 1/4" \text{ WELD} : \frac{1}{4} \times 0.707 \times 32.4 = 5.73 \text{ KLI STRESS} = 32.4 \text{ KSI}$$

NOTE - AS PER AWS D1.1, 5/16" MIN SIZE FILLET WELD REQUIRED. MIN SIZE SHOWN. DETAIL DWG

W14X283 $A_c = 83.0 \text{ sq in.}$ $d = 16.74' \text{ } l_w = 1.29'$ $b_f = 16.11' \text{ } t_f = 2.07'$

MAX. LOAD ON W14X109 = 387 K

W14X109 $A_c = 32.5 \text{ sq in}$ $A_c \text{ 2R } 1 \times 7.04 = 14.08 \text{ sq in}$ 46.08 sq in

$$\text{STRESS} = 387 / 46.08 = 8.4 \text{ KSI O.K.}$$

STIFFENER IN W14X283

 $A_c = 6 \times 1 \times 7.04 = 42.24 \text{ sq in}$ $WBS : 1.29 \times 14.32 = 18.47 \text{ sq in}$ 60.71 sq in

$$\text{STRESS} = 387 / 60.71 = 6.37 \text{ KSI O.K.}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNITS 5.2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	B.R	AP
FINAL	-8-04-00-12		DATE	DATE
VOID			6-19-81	11-24-81
SHEET 35 OF			DATE	DATE

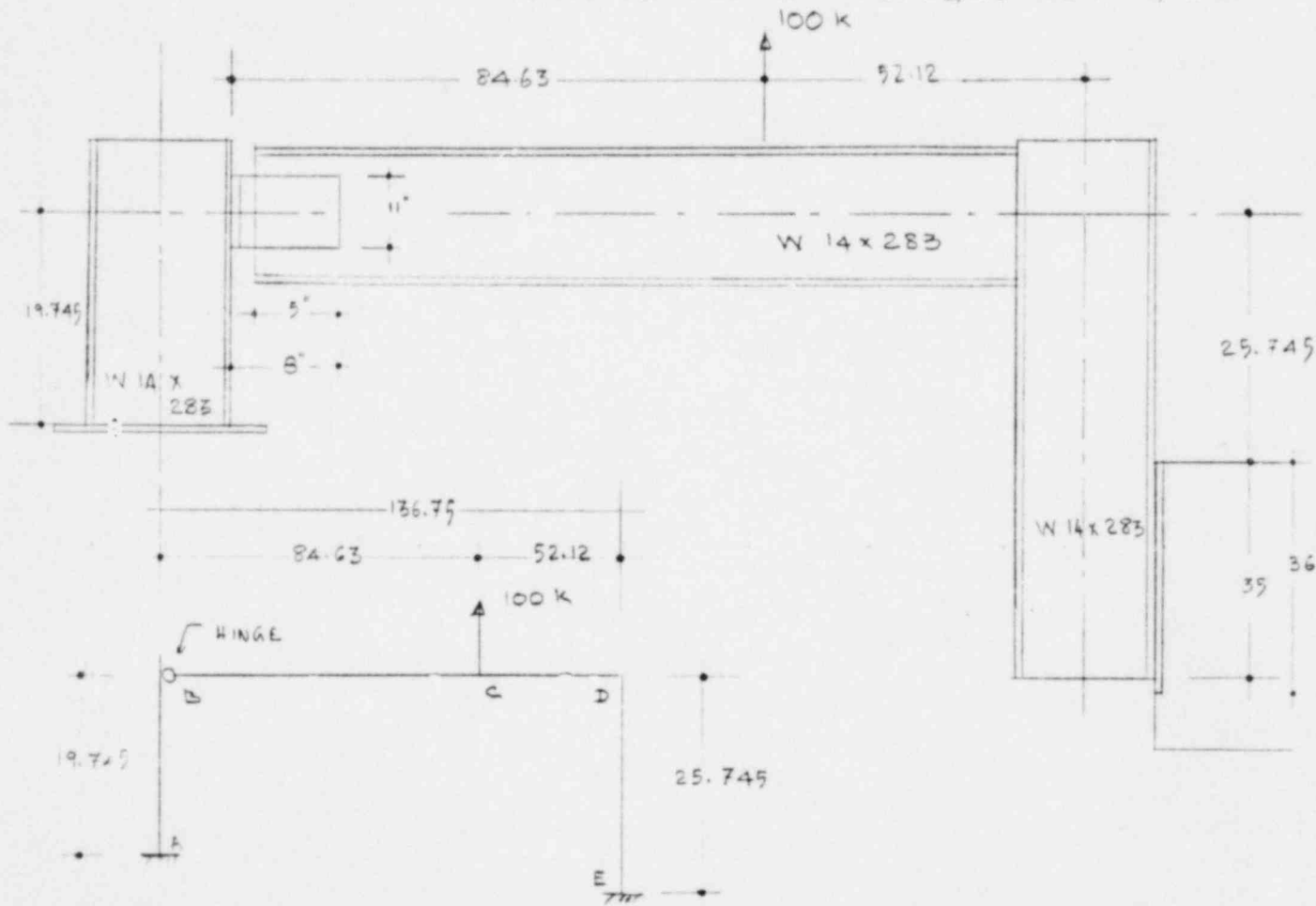
104 028

PW-49-2

LINE RC-49-1-14"

ANALYSIS OF FRAME

FRAME ANALYZED FOR 100 KIP LOAD. ACTUAL MOMENTS & FORCES OBTAINED BY MULTIPLYING RESULT BY 3.87.



$$K_{AB} = 0.75 \times \frac{1}{19.745} = 6.926$$

$$K_{BD} = 0.75 \times \frac{1}{136.75} = 1$$

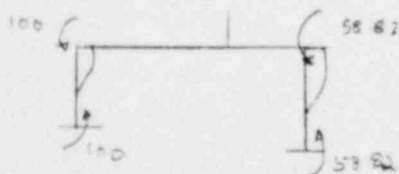
$$K_{DE} = \frac{1}{25.745} = 7.082$$

$$F_{em BD} = 100 \times \frac{52.12^2 \times 84.63}{136.75^2} = 1229$$

$$F_{em DB} = 100 \times \frac{84.63^2 \times 52.12}{136.75^2} = 1996$$

$$AB \frac{GEI \Delta}{L^2} = \frac{GEI \Delta}{19.745^2} = 100$$

$$DE \frac{GEI \Delta}{L^2} = \frac{6 \times GEI \Delta}{25.745^2} = 58.82$$



GENERAL COMPUTATION SHEET

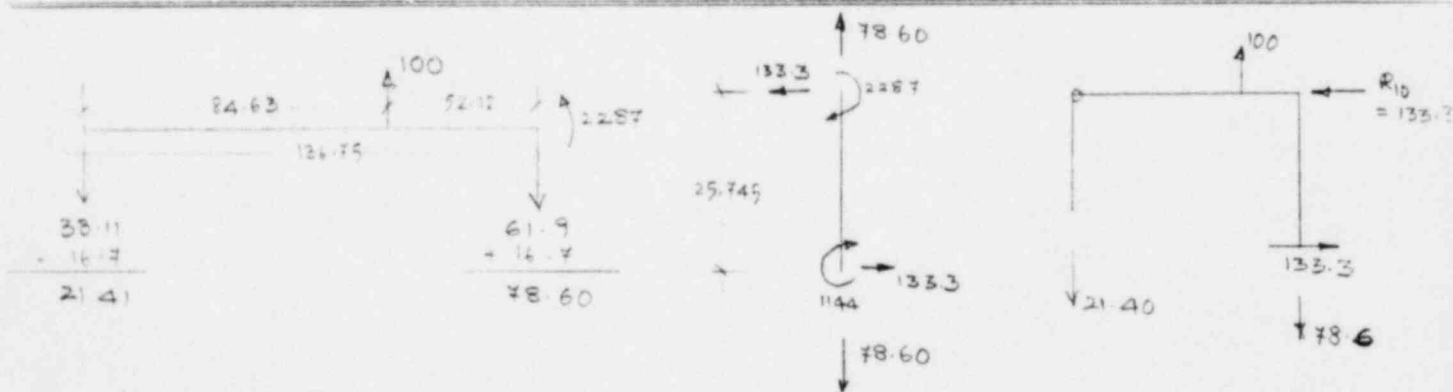
(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 182SUBJECT STRUCTURAL CALCS - PIPE WHIP RESTRAINT

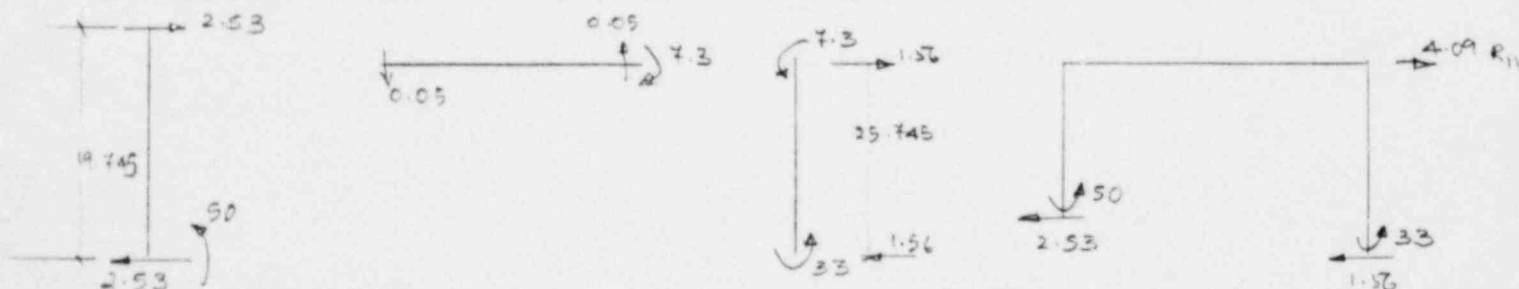
CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	AJT
FINAL	8-04-00-12			
VOID				
SHEET 36 OF			DATE	DATE
JO 9763 006				

10A 028 PW-49-2 LINE RC-49-1-14"

A		E		D		E		JOINTS
AB	BA	ED	DE	DE	DE	ED	ED	
				0.124	0.082			MEMBERS
								18
								DF
								FRM
0	0	+1229	-1996					
		-1229	-613					
0	0	0	-2611					
			+323.8	+2287.2				
0	0	0	-2287	+2287				
-100	-100	0	0	-58.82	-58.82			SWAY
+50	+100							
-50	0	0	0	-58.82	-58.82			
				+7.3	+51.50			
-50	0	0	+7.3	-7.3	-32.02			SWAY MOMENTS M ₁
-1630	0	0	+238	-238	-1076			X, M ₁
0	0	0	-2287	+2287	+1144			M ₀
-1630	0	0	-2049	+2049	+68			M = M ₀ + X, M ₁



NO SWAY CONDITION



$$R_{10} + X_1 R_{11} = 0 \quad ; \quad -133.3 + X_1 (4.09) = 0 \quad X_1 = \frac{133.3}{4.09} = 32.59$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

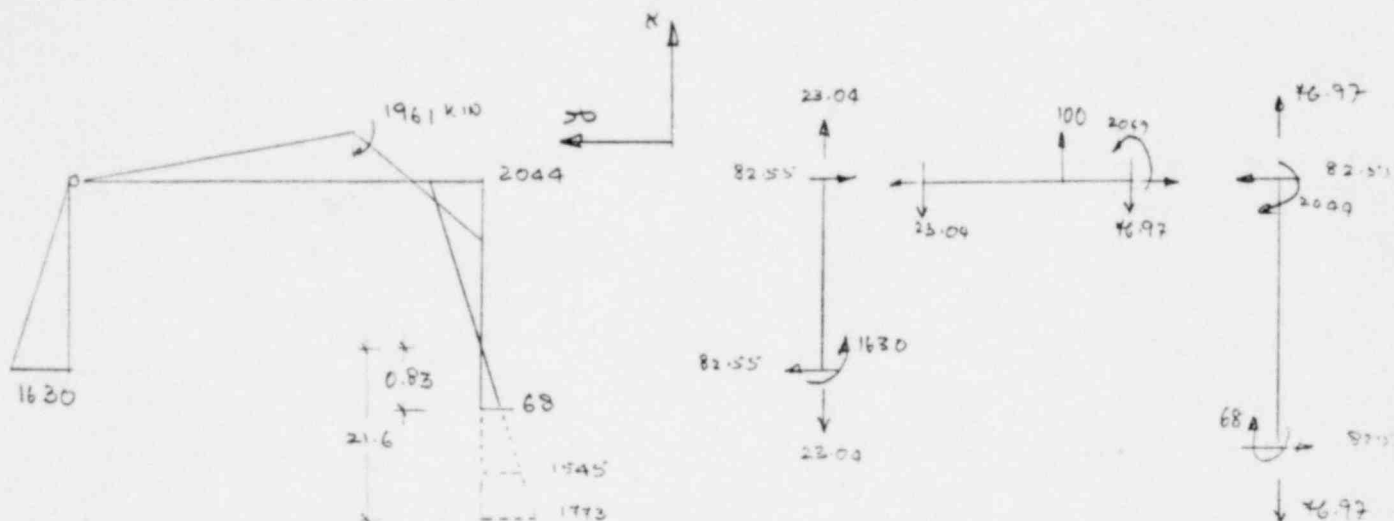
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1 & 2SUBJECT STRUCTURAL CALC. SIDE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ASP
FINAL	-B-04-00-12			
VOID				
SHEET 37 OF			DATE 6-22-81	DATE 11-28-81
JO 9763 006			DATE	DATE

104 028

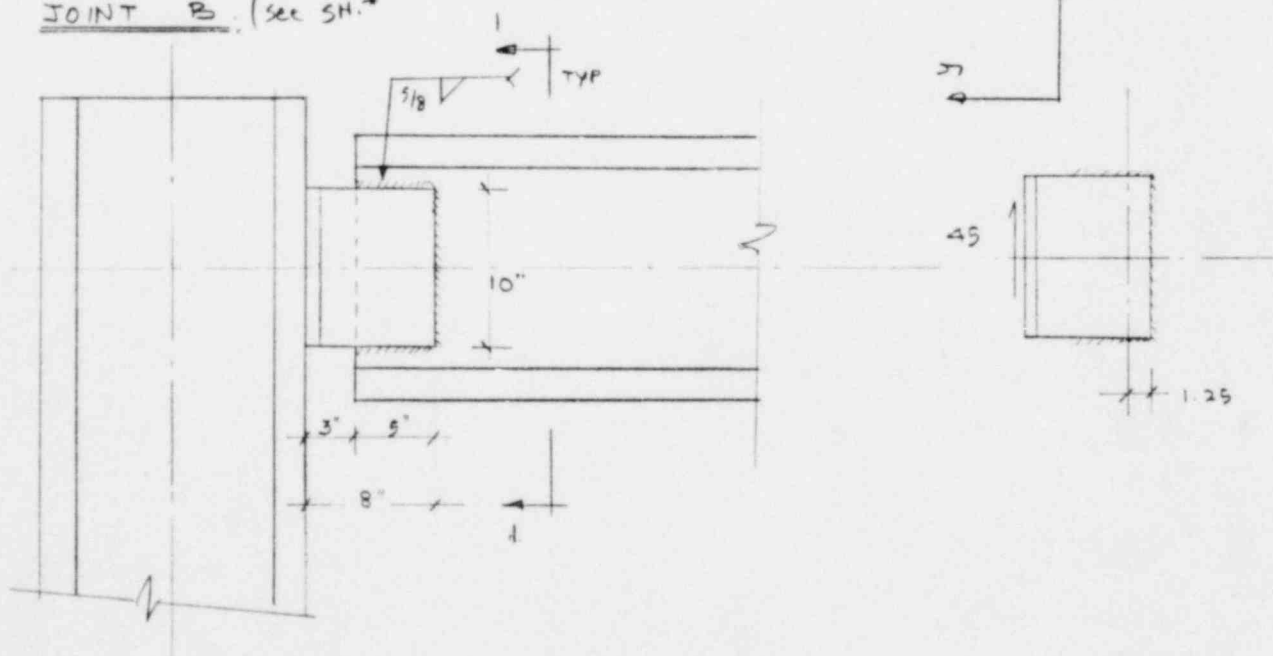
PW-49-2

LINE RC-49-1-14"



MOMENTS AND SHEARS SHOWN HERE ARE FOR 100 KIP LOAD.
 ACTUAL LOAD = 387 K. HENCE MULTIPLY BY 3.87 TO GET M & V

JOINT B: (see SH. #)



$$\begin{aligned}
 A_w &= 2 \times 5 + 10 = 20 \text{ IN} \\
 C_g &= 10 \times 0 + 2 \times 5 \times 2.5 / 20 = 1.25 \text{ IN} \\
 I_x &= 2 \times 5^3 / 12 + 2 \times 5 \times (2.5 - 1.25)^2 = 44.27 \text{ IN}^3 \\
 I_y &= 2 \times 5 \times 5^2 + 10^3 / 12 = 333.33 \text{ IN}^3 \\
 I_z &= 44.27 + 333.33 = 377.60 \text{ IN}^3
 \end{aligned}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)



CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	ER	AJP
FINAL	-8-04-00-12		DATE	DATE
VOID			6-22-81	11-28-81
SHEET 38 OF			DATE	D. TE
JO. 9763.886				

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 182

SUBJECT STRUCTURAL CALC - PIPE WHIP RESTRAINT

104 028

PW-49-2

LINE RC-49-1-14"

$$\begin{aligned}
 F_x &= 3.87 \times 23.00 = 90 \text{ K} & \text{PER LG} &= 45 \text{ K} \\
 F_y &= 3.87 \times 82.55 = 320 \text{ K} & &= 160 \text{ K} \\
 F_z &= 0 & &= 0
 \end{aligned}$$

$$M_x = M_y = 0$$

$$M_z = 45 (8 - 1.25) = 304 \text{ KIN}$$

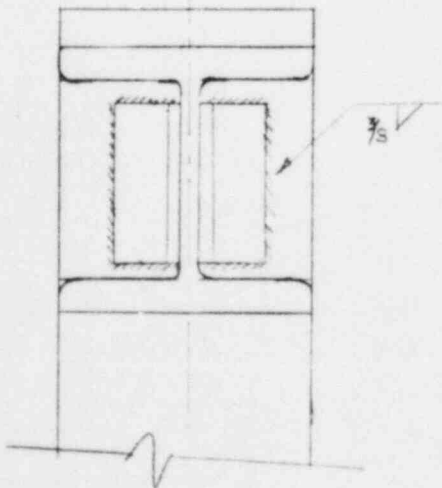
$$f_x = \frac{45}{20} + \frac{304}{377.6} \times 3.75 = 5.27 \text{ KLI}$$

$$f_y = \frac{160}{20} + \frac{304}{377.6} \times 5 = 12.02 \text{ KLI}$$

$$f_z = 0$$

$$f_r = \sqrt{5.27^2 + 12.02^2} = 13.12 \text{ KLI} = \frac{13}{0.625} = 21 \text{ ksi} < 32.4 \text{ ksi o.k.}$$

CONNECTION BET LR & VERTICAL W 14 X 283



SECTION 1-1

$$\begin{aligned}
 F_x &= 90 \text{ K} & M_x &= 0 \\
 F_y &= 320 \text{ K} & M_y &= 0 \\
 F_z &= 0 & M_z &= 0
 \end{aligned}$$

$$A_w = 2 \times (4 + 10 + 4) = 36 \text{ IN}$$

$$f_x = 90/36 = 2.5 \text{ KLI}$$

$$f_y = 320/36 = 8.89 \text{ KLI}$$

$$f_r = \sqrt{2.5^2 + 8.89^2} = 9.23 \text{ KLI} = \frac{9.23}{0.375} = 24.6 \text{ ksi} < 32.4 \text{ ksi o.k.}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)



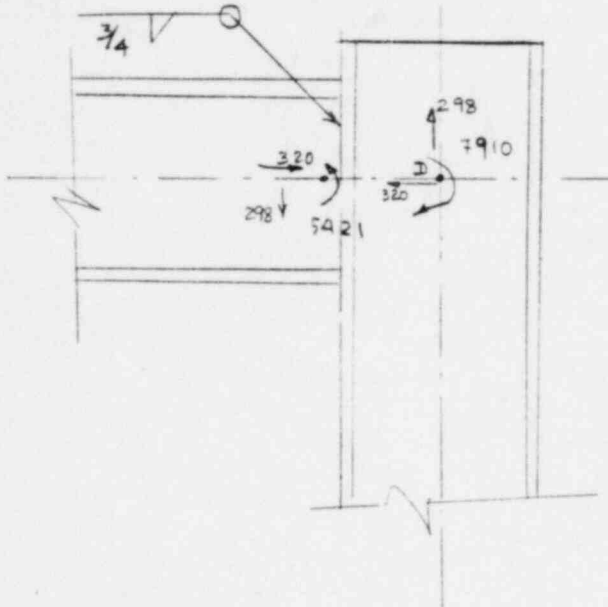
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1E2
 SUBJECT STRUCTURAL CALC. SIDE WHIP RESTRAINT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ALP
FINAL	-B-04-00-12		DATE 6-22-81	DATE 11-24-81
VOID				
SHEET	39 OF		DATE	DATE
JO	9763-006			

104 028

PW-49-2

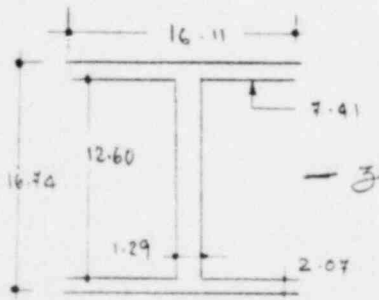
LINE RC-49-1-14'

JOINT D

AT THE FACE OF THE
COLUMN MOMENT

$$3.87 \left(2044 - \frac{(2044 + 1961) \times 16.74}{52.12} \right) = 5421 \text{ k-in}$$

$$\begin{aligned} F_x &= 298 \text{ k} & m_x &= 0 \\ F_y &= 320 \text{ k} & m_y &= 0 \\ F_z &= 0 & m_z &= 5421 \text{ k-in} \end{aligned}$$



$$A_w = 2(16.11 + 12.6) + 4 \times 7.41 = 87.06 \text{ in}$$

$$I_z = 2 \times 16.11 \times 8.37^2 + 4 \times 7.41 \times 6.3^2 + 2 \times \frac{12.6^3}{12} = 3767 \text{ in}^4$$

$$S_z = 3767 / 8.37 = 450 \text{ in}^3$$

$$f_x = 298 / 87.06 = 3.42 \text{ ksi}$$

$$f_y = 320 / 87.06 + 5421 / 450 = 15.72 \text{ ksi}$$

$$f_o = \sqrt{3.42^2 + 15.72^2} = 16.09 = \frac{16.09}{0.75} = 21.5 \text{ ksi} < 32 \text{ ksi} \quad \text{ok}$$

JOINT A W 14 x 283

ALL AROUND WELD $A_w = 87.06 \text{ in}$ $S = 450 \text{ in}^3$

$$F_x = 3.87 \times 23.04 = 90 \text{ k}$$

$$F_y = 3.87 \times 82.55 = 320 \text{ k}$$

$$M_z = 3.87 \times 1630 = 6308 \text{ k-in}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1E2SUBJECT STRUCTURAL CALC FOR WIDE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	AR	AJR
FINAL	<u>-B-04-00-12</u>			
VOID				
SHEET <u>40</u> OF			DATE <u>6.22.87</u>	DATE <u>11-28-81</u>
JO <u>9763.006</u>			DATE	DATE

104 028

PW-49-2

LINE RC-49-1-14'

$$f_x = \frac{90}{87.06} + \frac{6308}{450} = 15.05 \text{ K/L}$$

$$f_y = \frac{320}{87.06} = 3.68 \text{ K/L}$$

$$f_o = \sqrt{15.05^2 + 3.68^2} = 15.50 \text{ K/L} = \frac{15.5}{0.75} = 20.7 \text{ ksi} < 32.4 \text{ ksi OK}$$

JOINT E

$$F_x = 3.87 \times 77 = 298 \text{ K}$$

$$F_y = 3.87 \times 82.55 = 320 \text{ K}$$

$$N_g = 3.87 \times 1773 = 6862 \text{ K IN}$$

$$A_w = 2 \times 35 + 16.11 = 86.11$$

$$I = 2 \times \frac{35^3}{12} + 2 \times 35(17.5 - 14.22)^2 + 16.11 \times 14.22^2$$

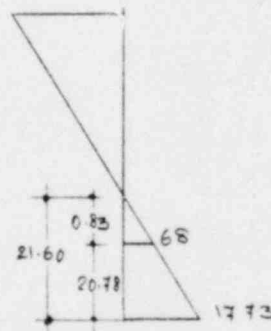
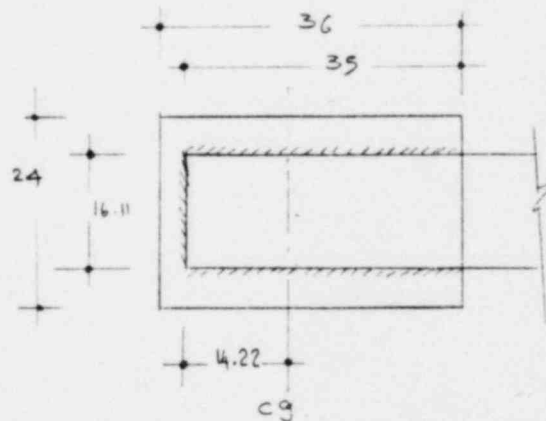
$$= 11156 \text{ in}^4$$

$$S = 11156 / (35 - 14.22) = 536.8$$

$$f_x = 298 / 86.11 = 3.46 \text{ K/L}$$

$$f_y = \frac{320}{86.11} + \frac{6862}{536.8} = 16.54 \text{ K/L}$$

$$f_o = \sqrt{3.46^2 + 16.54^2} = 16.90 \text{ K/L} = \frac{16.90}{0.75} = 22.5 \text{ ksi} < 32.4 \text{ ksi OK}$$



GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATIONUNIT/S 1 & 2SUBJECT STRUCTURAL CALCS - PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	ER	AJV
FINAL	<u>B-04-00-12</u>			
VOID				
SHEET <u>41</u> OF <u>41</u>			DATE <u>6.23.81</u>	DATE <u>1.24.81</u>
JO <u>9763.006</u>			DATE	DATE

104 028

PW-49.2

LINE RC-49-1-4"

CHECK MEMBER

MAX. FORCES AT JOINT D

W 14X283 $d = 16.74$ $t_w = 1.29$ $A_c = 83.3$ SQ IN $S = 459$ IN⁴

$$F_x = 3.87 \times F_z = 298 \text{ K SHEAR}$$

$$F_y = 3.87 \times 83 = 322 \text{ K AXIAL}$$

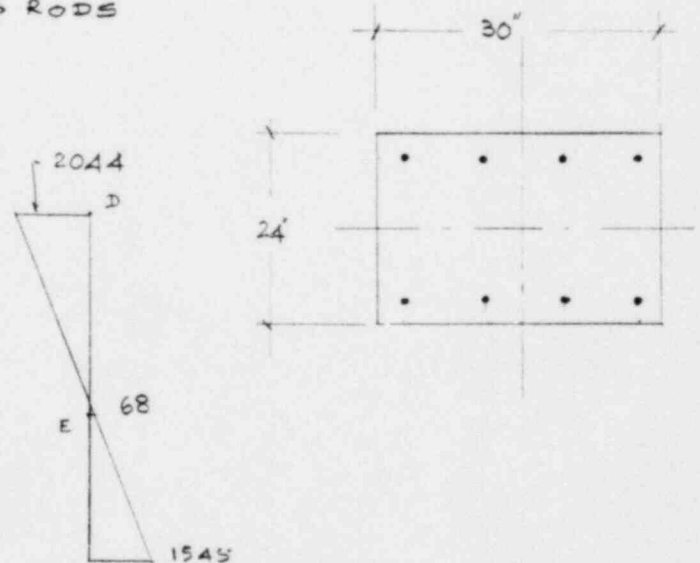
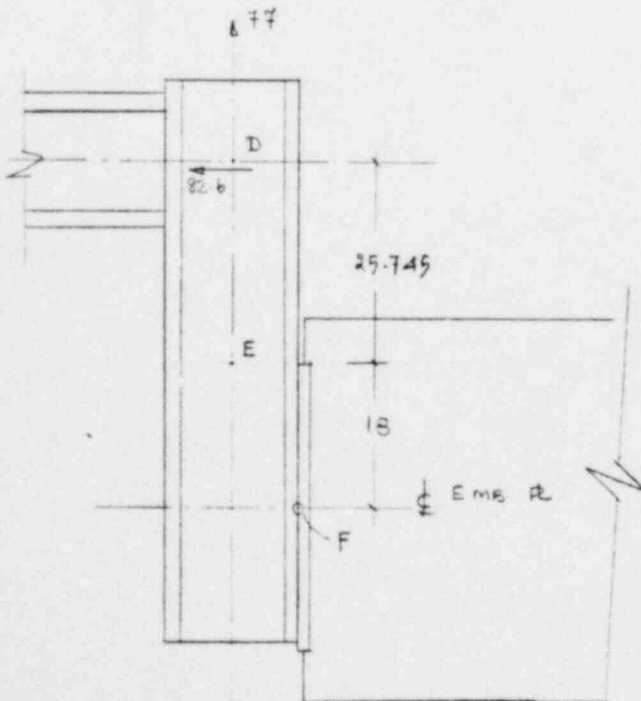
$$M_z = 3.87 \times 2044 = 7910 \text{ K IN MOMENT } M_y$$

$$\text{AXIAL STRESS} = 322 / 83.3 = 3.87 \text{ KSI TENSION}$$

$$\text{SHEAR STRESS} = 298 / (16.74 \times 1.29) = 13.8 \text{ KSI} < 19.8 \text{ O.K.}$$

$$\text{BENDING STRESS} = 7910 / 459 = 17.23 \text{ KSI}$$

$$\text{INTERACTION} \quad \frac{3.87}{32.4} + \frac{17.23}{32.4} = 0.65 < 1 \quad \text{O.K.}$$

EMB. PLATE 147SIZE $1\frac{1}{2} \times 24 \times 36$ + 8 - $1\frac{3}{4}$ ϕ RODS

4.2.3 ANALYSIS OF PRR PW-49 4b

GENERAL COMPUTATION SHEET

(DISCIPLINE)

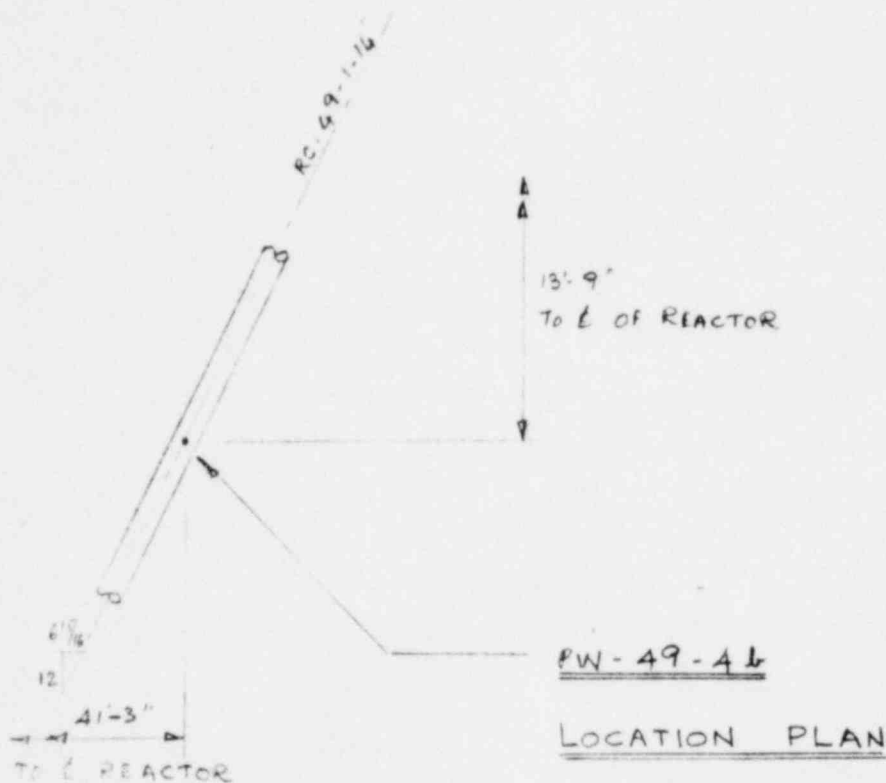


NAME OF COMPANY: PSNH—SEABROOK STATION UNIT/S: '12

SUBJECT: STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ARUP
FINAL	-8-04-00-12			
VOID				
SHEET 43 OF			DATE 12.1.81	DATE 12.9.21
JO 9763.006			DATE	DATE

104 028 PRR NO PW-49-46 LINE RC-49.1-14"



BLOW DOWN FORCE = 277 KIPS DOWNWARD.

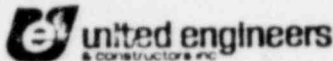
Y - COLD GAP = -7/16"

Y - HOT GAP = -1/4"

b - COLD GAP = 2 3/8"

b - HOT GAP = 3/16"

(DISCIPLINE)



NAME OF COMPANY **PSNH-SEABROOK STATION** UNIT/S

SUBJECT **STRUCTURAL CALC - PIPE WHIP RESTRAINT**

CALC SET NO.		REV	COMP BY	CHKD BY
PRELIM		0	EL	AKVP
FINAL	-B-04-00-12		DATE 12.81	DATE 12.7.81
VOID				
SHEET 44 OF			DATE	DATE
JO 9263.006				

104 028

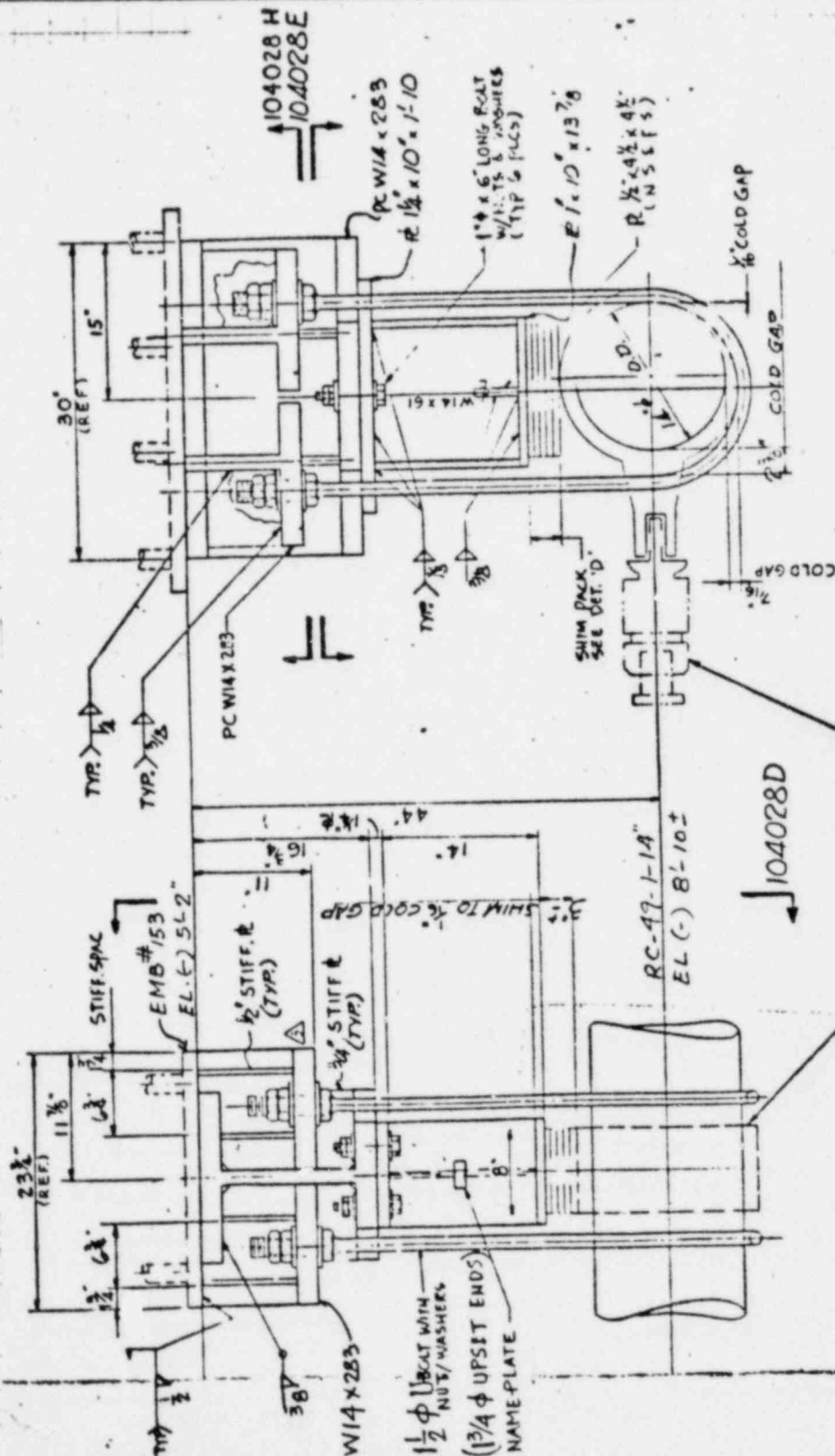
PRR: PW-49-4b

LINE: RC-49-1-14"

PRR No -
PW-49-4b

LINE -
RC-49-1-14"

F_B = 277 K
DOWNWARD



REV. 4.

SECTION-104028D

PIPE SUPPLY #49-RM-3
(BY OTHERS) SEE DWG
9763-M-8049-RM-3

SECTION-104028C

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1,2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	B. R.	ARUP
FINAL	-B-04-00-12			
VOID				
SHEET 45 OF			DATE 12.3.81	DATE 12.9.81
JO 9763.006			DATE	DATE

104 028

PW-49-4 b

LINE RC-49-1-14

U-BOLT ANALYSIS

COLD GAP AT U-BOLT = $7/16"$
 HOT GAP AT U-BOLT = $1/4"$
 BLOW DOWN LOAD = 277 KIPS

LENGTH OF U-BOLT OF $\phi 1.5" = 41-11 = 30$ IN $A = 1.767$ SQ IN
 U-BOLT STIFFNESS = $4AE/L = \frac{4 \times 1.767 \times 29 \times 10^3}{30} = 6832$ K/IN

DYNAMIC LOAD FACTOR, DLF = $1 + \sqrt{1 + \frac{2 \times 6832 \times 0.25}{277}} = 4.65$
 RESTRAINT LOAD $R_P = 4.65 \times 277 = 1288$ K

STRESS IN U-BOLT = $\frac{1288}{4 \times 1.767} = 182$ KSI

U-BOLT GOES PLASTIC.

PLASTIC LOAD, $R_P = 4 \times 1.767 \times 50 = 353.4 \approx 354$ KIPS

MATERIAL OF U-BOLT A276 XM-11.

$f_y = 50$ KSI
 $f_u = 80$ KSI
 $E_u = 0.45$

THREAD DIAMETER = 1.75 IN. 8 THREADS PER INCH.
 TENSION AREA $A_t = 0.785 \left[1.75 - \frac{0.9743}{8} \right]^2 = 2.08$ SQ IN.

STRESS IN THREAD = $\frac{354}{(4 \times 2.08)} = 42.54$ KSI

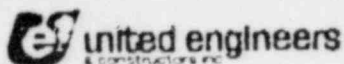
STRESS IN THREA = $\frac{42.5}{50} = 0.85$
 STRESS IN SHANK

CHECK U-BOLT FOR ELONGATION

$\delta =$ TOTAL ELONGATION = $\delta_e + \delta_p$
 $\delta_e =$ ELASTIC ELONGATION = $\epsilon_e L = 1.724 \times 10^{-3} \times 20 = 0.0345$ IN
 $\delta_H =$ HOT GAP.

$F_B (\delta_H + \delta_e + \delta_p) = R_P (\delta_H/2 + \delta_p)$
 $277 (0.25 + 0.0345 + \delta_p) = 354 (0.125 + \delta_p)$
 $83.57 + 277\delta_p = 44.25 + 354\delta_p$
 $\delta_p = 0.966$ IN.

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNITS 1, 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHKD BY
PRELIM		0	ES-EL	ARVP
FINAL	-B-111-00-12		DATE 12-3-31	DATE 10-7-21
VOID				
SHEET 46 OF		1	ES-EL	ARVP
JO 4462.000			DATE 2-22-82	DATE 9-22-81

04028 1W-49.46 LINE RC-49.1.14

$$\delta_P = 0.966 \text{ IN.} \quad \epsilon_P = 0.766 / 20 = 0.0322$$

$$\epsilon = \epsilon_P + \epsilon_H = 1.724 \times 10^{-2} + 0.0322 = 0.034 < \frac{\epsilon_u}{2} (0.225) \quad \text{O.K.}$$

CHECK FLANGE TO RESIST U-BOLT LOAD. (SEE SKETCH)

LOAD PER LEG OF U-BOLT = $354 / 4 = 88.5 \text{ K}$
 CANTILEVER EFFECTIVE SPAN = $3.4975 - 1.49 / 2 = 2.8475 \text{ IN}$
 EFFECTIVE WIDTH = $6.75 - 0.5 = 6.25 \text{ IN}$

SIMPLY SUPPORTED EFF. SPAN = 6.75 IN
 WIDTH = $2.8475 + 4.5625 = 7.41 \text{ IN}$

TOTAL LOAD $P = 88.5 \text{ K}$
 SHARE BY SIMPLE BEAM = kP ; BY CANTILEVER = $(1-k)P$

DEFLECTION OF CANTILEVER = $\frac{(1-k) \times 2.8475^3 P}{3EI}$ $I_1 = 6.25 \times 2.07^3 / 12 = 4.62$

DEFLECTION OF S.E. SPAN = $\frac{kP \times 3.4975^3 \times 3.5}{3 \times EI_2 \times 6.75}$ $I_2 = 7.41 \times 2.07^3 / 12 = 5.08 \text{ IN}$

EQUATING DEFLECTIONS $\frac{(1-k) \times 2.8475^3}{3 \times 4.62} = \frac{k \times 3.25^3 \times 3.5}{3 \times 5.08 \times 6.75}$
 $(1-k) 4.997 = 3.458 k$
 $k = 0.59$

LOAD ON S.E. BEAM = $0.59 \times 88.5 = 52.2 \text{ K}$
 LOAD ON CANTILEVER = $0.41 \times 88.5 = 36.3 \text{ K}$

MOMENT IN S.E. BEAM = $\frac{52.2 \times 3.25 \times 3.5}{6.75} = 89 \text{ K IN.}$

CANTILEVER MOMENT = $36.3 \times 2.845 = 103.3 \text{ K IN.}$
 STRESS = $\frac{103.3 \times 1.04}{4.62} = 23.3 \text{ KSI} < 32.4 \text{ KSI}$

STIFFENER "2"

LOAD ON STIFFENER = $52.2 \times 3.5 / 6.75 = 27.1 \text{ K TENSION}$
 STIFFENER STRESS = $27.1 / (7.41 \times 0.5) = 7.31 \text{ KSI} < 32.4 \text{ O.K.}$

WELD = $3/8"$; AREA OF WELD = $0.375 \times 0.707 \times 2 \times 7.41 = 3.93 \text{ SQ IN}$

WELD STRESS = $27.1 / 3.93 = 6.89 \text{ KSI} < 32.4 \text{ O.K.}$

WELD ON 2ND EDGE NOMINAL AS STIFFENER IS IN TENSION & $3/8"$ WELD ADEQ.
 NOTE - AS PER AWS D1.1, $5/16"$ MIN SIZE FILLET WELD IS REQ'D. SHOWN ON:

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 12
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	B.R.	ARP
FINAL	-B-04-00-12		DATE 12.3.81	DATE 12.9.81
VOID				
SHEET 47 OF			DATE	DATE
JO 9763 006				

104028

PW-49-46

LINE RC-49-1-14

WEB OF PC W14X253

LOAD ON WEB = CANTILEVER LOAD = 36.3 K
 STRESS = $36.3 / (6.25 \times 1.29) = 4.5$ KSI

WELD AT BOTTOM = $0.375 \times 0.707 \times (16.11 \times 2 \times 0.9) = 8.01$ SQ IN
 STRESS = $36.3 / 8.01 = 4.53$ KSI < 32.4 O.K.

W 14 X 283

LOAD TRANSMITTED THROUGH BOTTOM FLANGE WELDED TO THE
 EMP. PLATE.

AREA OF $\frac{1}{2}$ " WELD = $4 \times 4.5 \times 2 \times 0.5 \times 0.707 = 12.726$ SQ IN
 AREA OF $\frac{3}{8}$ " WELD = $16.11 \times 2 \times 0.707 \times 0.375 = 8.54$
 TOTAL = 21.266 SQ IN

WELD STRESS = $354 / 21.266 = 16.64$ KSI < 32.4 O.K.

EMBEDDED PLATE

A No 153 TYPE 13 $1\frac{1}{2} \times 24 \times 36$ + 8 - $1\frac{3}{4}$ " ϕ RODS

P = + 354 K
 MOMENT = 0
 SHEAR = 0

GENERAL COMPUTATION SHEET

(DISCIPLINE)

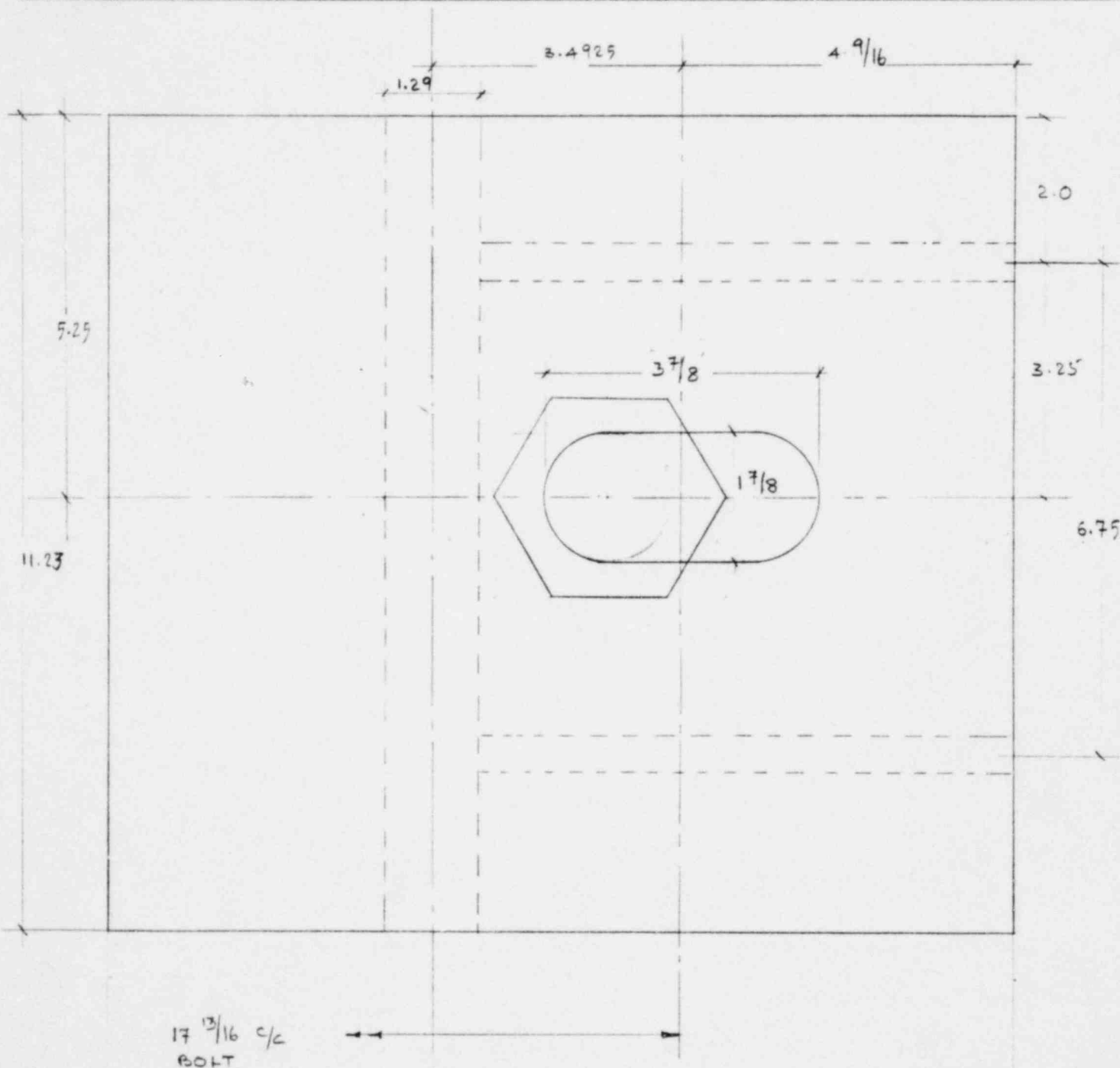
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 182SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ARUP
FINAL	-B-04-00-12		DATE	DATE
VOID			6.18.81	12.9.81.
SHEET 48 OF			DATE	DATE
J0 9763.006				

104025

PW-49-48

LINE RC-49-1-14"

SLOTTED HOLE FOR U-BOLT

GENERAL COMPUTATION SHEET

(DISCIPLINE)



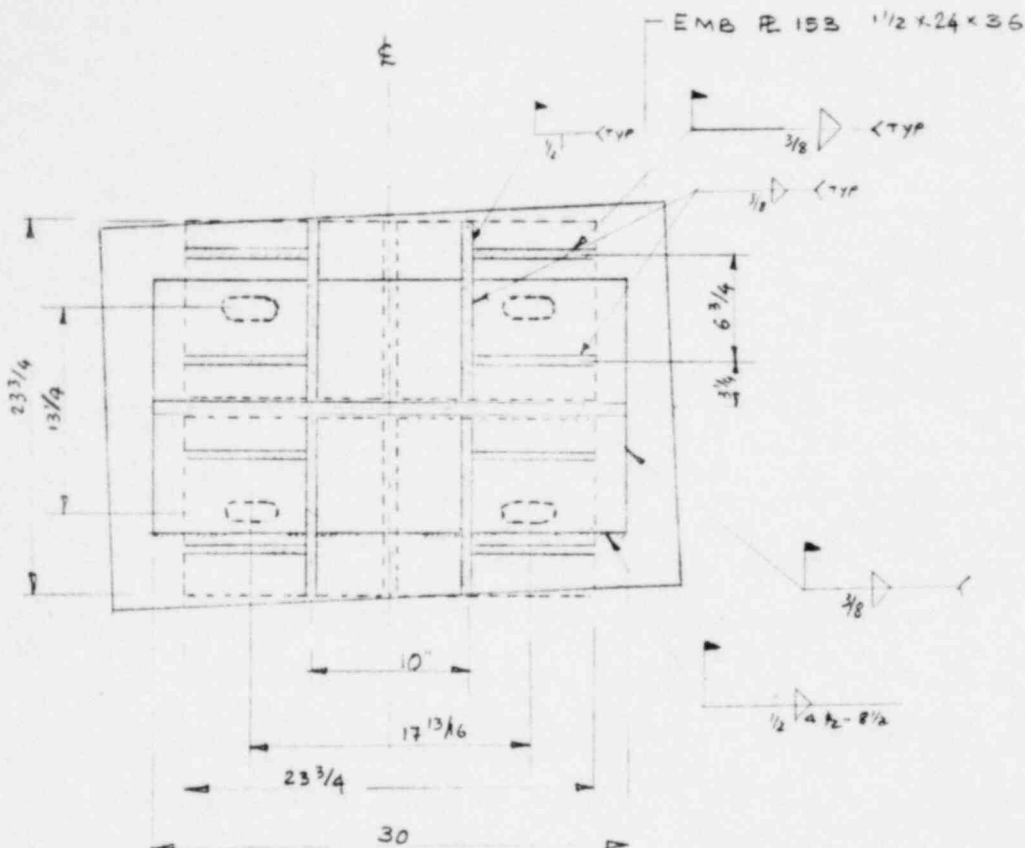
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 42
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO	REV	COMP BY	CHK'D BY
PRELIM		0	DRP
FINAL	-8-04-00-12	DATE	DATE
VOID			12.9.81
SHEET 49 OF		DATE	DATE
JO 9763 006			

104 028

PW-49-4 1/2

LINE RC-49-1-14"

SECTIONAL PLANU-BOLTSHANK DIA = 1.375 IN $A_g = 1.485 \text{ sq in}$ NOMINAL DIA OF THREADS $1\frac{5}{8}'' = 1.625 \text{ IN}$

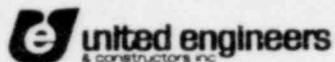
NO OF THREADS PER INCH : 8

STRESS AREA = $0.785 \left(1.625 - \frac{0.974}{8} \right)^2 = 1.77 \text{ sq in}$ STRESS CONCENTRATION FACTOR FOR $r/d = 1$ IS 1.18ALLOWABLE STRESS IN THREADED END = 0.9 F_y

CONDITION IS $\frac{1.77}{1.18} \times 0.9$ SHOULD BE GREATER THAN 1.485 sq in
 (SHANK CROSS SECTIONAL AREA)

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	BR	ARUP
FINAL	-B-04-00-12		DATE 6.19.81	DATE 12.9.81
VOID				
SHEET	50 OF		DATE	DATE
JO	9263-006			

104 028

PW-49-46

LINE RC-49-1-14'

$$\frac{1.77}{1.18} \times 0.9 = 1.35 \quad \text{LESS THAN } 1.485$$

HENCE A LARGER DIA FOR THREAD TO BE CHOSEN.

$$\text{DIA} = 1.75 \text{ IN} \quad \text{NO. OF THREADS PER INCH} = 8$$

$$\text{STRESS AREA} = 0.785 \left(1.75 - \frac{0.974}{8} \right)^2 = 2.08 \text{ SQ IN.}$$

$$\frac{2.08}{1.18} \times 0.9 = 1.586 > 1.485$$

DIA 1.75 FOR THREADS IS ADEQUATE.

THREAD LENGTH CALCULATION

$$\begin{aligned} 2 \text{ NUT THICKNESS} &= 3.50 \text{ IN} \\ \text{WASHER} &= 0.18 \text{ IN} \\ \text{WALL + PIPE TOLERANCE} &= 2.00 \text{ IN} \\ 2 \text{ TH EXTENSION} &= 0.25 \text{ IN} \\ \hline &5.93 \end{aligned}$$

$$\begin{aligned} \text{FLANGE THICKNESS} &2.07 \\ 1 \text{ NUT THICKNESS} &1.75 \\ 4 \text{ THREADS} &0.50 \\ \hline &10.25 \text{ IN.} \end{aligned}$$

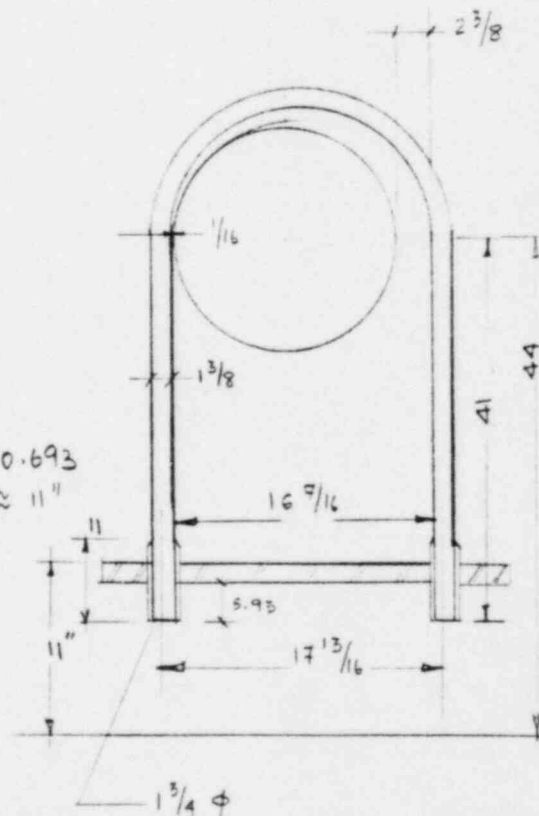
$$\text{COLD GAP} = 7/16"$$

$$\begin{aligned} \text{LENGTH OF } 1\frac{3}{4}" \text{ ROD NECESSARY} &= 10.25 + 0.693 \\ &= 10.943 \approx 11" \end{aligned}$$

$$\text{LENGTH OF } 1\frac{3}{8}" \text{ ROD}$$

$$2(41.0 - 11) + \pi \times \frac{17\frac{13}{16}}{2} = 87.98$$

$$\quad \quad \quad = 88$$



4.1.4 ANALYSIS OF PRR PW-49-3a

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1 & 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM			B.R.	ARUP
FINAL	<u>-B-C4-00-12</u>	0	DATE 3-27-81	DATE 12-14-81
VOID				
SHEET	52	OF		
JO.	9763-006		DATE	DATE

104 029

PW-49-3a

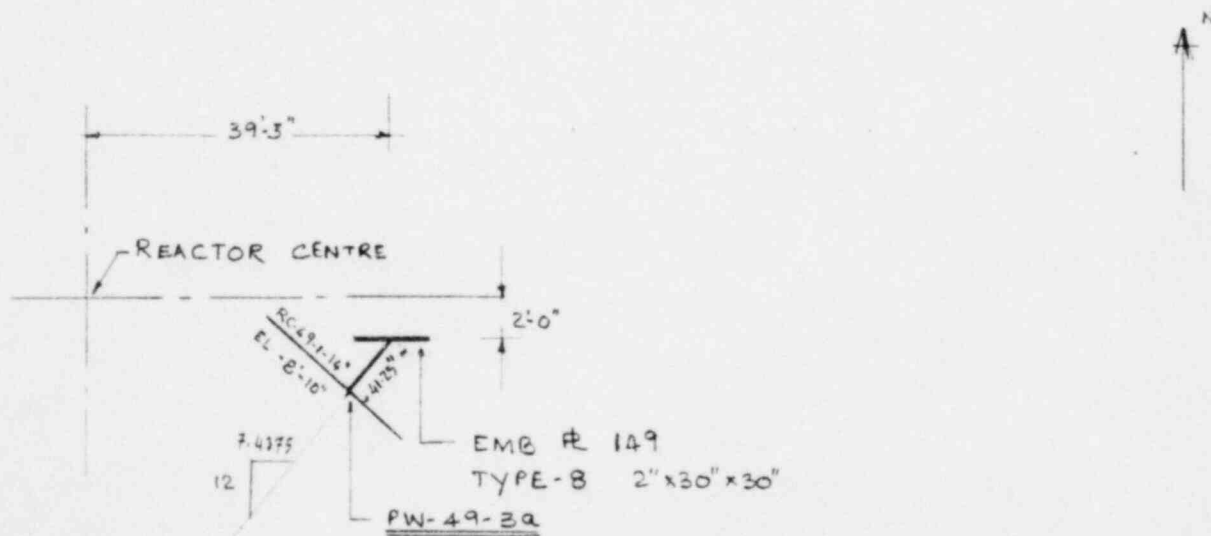
LINE RC-49-1-14"

BLOW DOWN FORCE, $F_B = 277 \text{ K}$ N 31.75° E

COLD GAP = - { DIRECTION Y
 HOT GAP = 0

COLD GAP = $2\frac{1}{4}$ { DIRECTION b
 HOT GAP = $3\frac{1}{16}$

CRUSH PAD CORE = $16.5 \times 12 \times 19\frac{1}{4}$
 GAUGE 12

LOCATION PLANSUMMARY 9.18.81

1. CRUSH PAD HAS BEEN DELETED AS PRESENT LOAD IS IN OPPOSITE DIRECTION ONLY
2. W16X77 IS NOW ADEQUATE AS LOAD IS IN OPPOSITE DIRECTION
3. MEMBERS, WELDS AND EMB. PLATE - GOOD
4. W12X120 AT BOTTOM IS W10X112 NOW. THIS IS OK AS THERE IS NO LOAD ON IT.

GENERAL COMPUTATION SHEET

(DISCIPLINE)

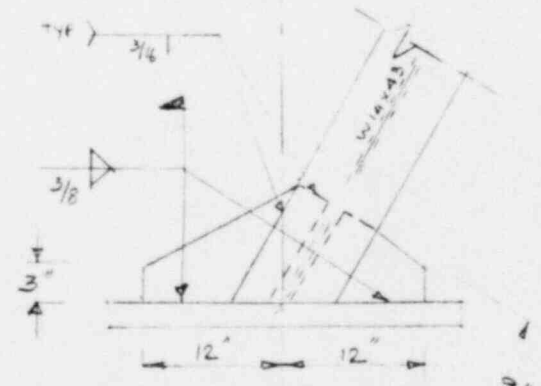
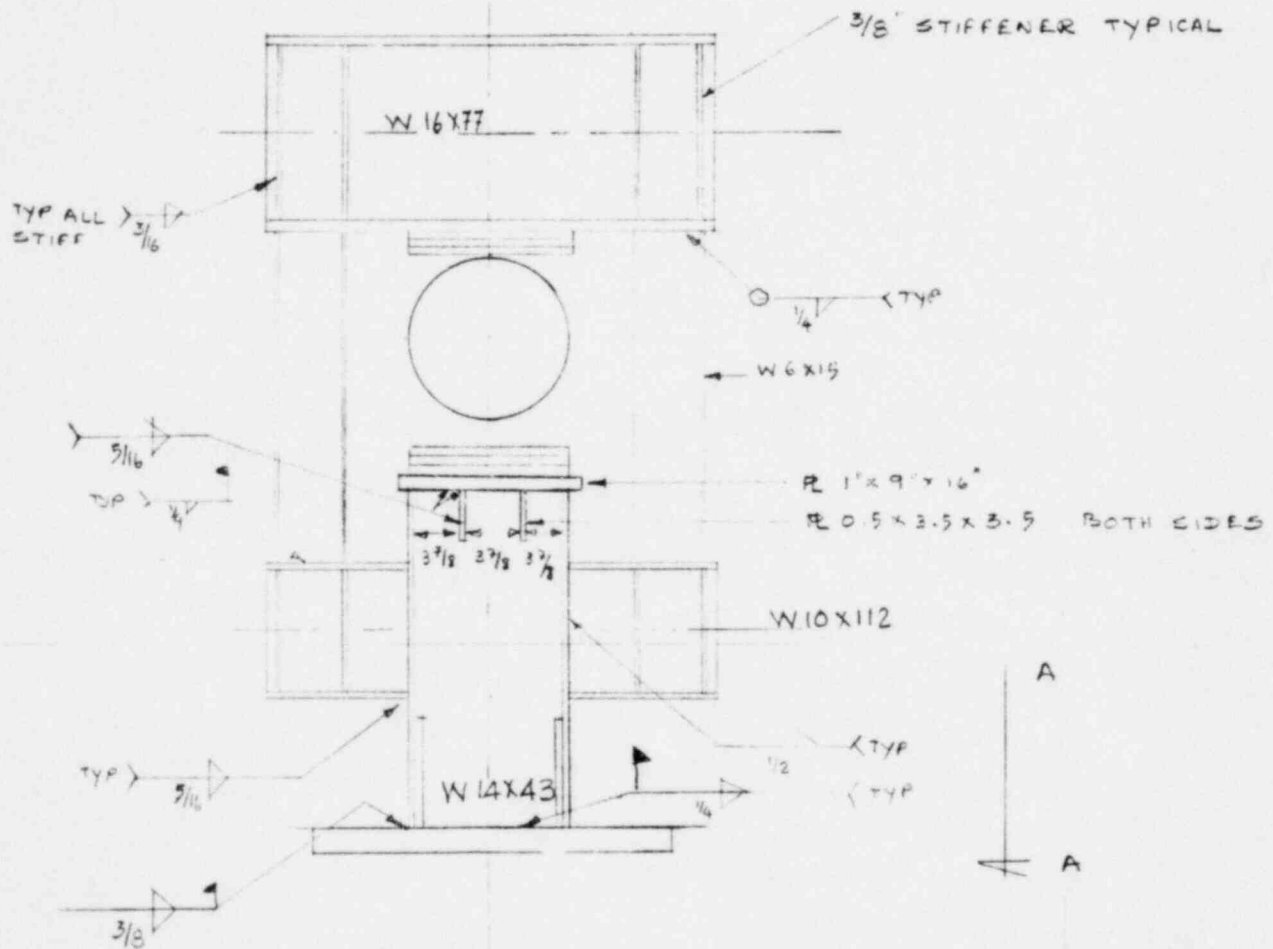
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	ER	AKUP
FINAL	-B-04-00-12		DATE 12.14.81	DATE 12.14.81
VOID				
SHEET 53	OF		DATE	DATE
JO 9763-006				

104029

PW-49-30

RC-49-1-14"



VIEW A-A

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	P R	ARUP
FINAL	-B-04-00-12			
VOID				
SHEET <u>54</u> OF			DATE 12-4-81	DATE 12-14-81
JO 9763.006			DATE	DATE

104 029

PW-49-30

LINE RC-49-1-14

W14 x 43

BLOW DOWN FORCE = 277 K
 HOT GAP = 0.1875 IN

W14 x 43

A = 12.6 SQ IN
 $\lambda = 41.25 - (7 + 1.875 + 3 + 1)$
 = 28.375 IN

STIFFNESS = AE/L
 = $12.6 \times 29 \times 10^3 / 28.375$
 = 12877.5 K/IN

DYNAMIC LOAD FACTOR = $1 + \left[\frac{1 + \frac{2 \times 12877.5 \times 0.1875}{277}}{2} \right]^{1/2}$
 = 5.29

RESTRAINT LOAD = $5.29 \times 277 = 1465$ KIPS.

STRESS IN W14 x 43 = $1465 / 12.6 = 116.29$ KSI
 STRESS IS BEYOND YIELD. SECTION WOULD GO PLASTIC

$\lambda_y = 1.89$ IN CLEAR LENGTH OF COLUMN = $28.375 - 9 = 19.375$ IN.
 $K\lambda/\lambda_y = \frac{2 \times 19.375}{1.89} = 20.5 < 25$ NO BUCKLING OF COLUMN.

CAPACITY OF SECTION = $36 \times 12.6 = 453.6$ K

CHECK FOR DEFORMATION

$$\epsilon_e = 1.24 \times 10^{-3}$$

$$\delta e = 1.24 \times 10^{-3} \times 28.375 = 0.035$$

$$277(0.1875 + 0.035 + \delta p) = 453.6 \left(\frac{0.035}{2} + \delta p \right)$$

$$61.63 + 277 \delta p = 7.938 + 453.6 \delta p$$

$$\delta p = 0.304 \text{ IN}$$

$$\epsilon_p = 0.304 / 28.375 = 0.0107$$

$$\text{TOTAL STRAIN} = 1.24 \times 10^{-3} + 0.0107 = 0.01194$$

$E_u = 0.19$ FOR A-36 STEEL

$$\epsilon_u/2 = 0.095$$

TOTAL STRAIN IS LESS THAN 50% OF ULTIMATE STRAIN. O.K.

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 112
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM			B.R.	ARUP
FINAL	-B-04-00-12	0	DATE 12.4.81	DATE 12.14.81
VOID				
SHEET <u>55</u> OF			DATE	DATE
JO. 9763.006				

104 029

PW-49-30

RC-49-1-14

CHECK CAP PLATE ON W14X43

$d = 13.66$ IN $t_w = 0.305$
 $b_f = 7.995$ IN $t_f = 0.53$

LOAD ON COL = 454 K

SHIM PLATE 10×12.5 "

FOR PIPE IN CORRECT POSITION SHIM THICKNESS = 2.625 IN

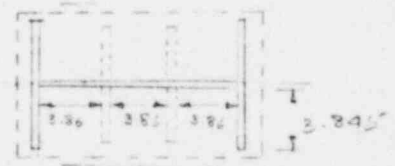
FOR A 1" OFFSET THICKNESS OF SHIM = 1.625 IN

DUE TO THIS THICKNESS A UNIFORM DISTRIBUTION OF LOAD CAN BE ASSUMED

THICKNESS OF CAP PLATE = 1 IN $l = 16$ " $b = 9$ "

PLATE APPROXIMATED TO CONDITION OF
 2 EDGES SIMPLY SUPPORTED ONE EDGE
 FREE AND ONE EDGE FIXED

REFER. 3, FORMULAE FOR STRESS AND STRAIN
 BY R.J. ROARK. CASE - 7

 $l = 3.56$ IN $l_e = 3.845$ IN $l/l_e = 1.004$ $\rho_1 = 0.67$ $\rho_2 = 0.566$ INTENSITY OF LOADING = $454 / (9 \times 12.5) = 4.04$ KSI

FOR A MIN THICKNESS 0.15 IN OF PLATE AND SHIM
 ACTING TOGETHER STRESS IN PLATE

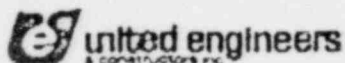
$$= \frac{4.04 \times 0.67 \times 3.845^2}{1.5^2} = 17.78 \text{ KSI}$$

OK

STIFFENERLOAD IN ONE PANEL = $454 / 6 = 75.67$ K $2/3$ OF LOAD TO STIFFENER = 50.4 K (CONSERVATIVE ASSUMPTION)STRESS IN STIFFENER = $50.4 / (0.5 \times 3.5) = 28.8$ KSI (32.4) OK $5/16$ " WELDWELD AREA IN EACH PROJECTION = $3.5 \times 2 \times 0.707 \times 0.3125 = 1.547$ SQ IN.STRESS = $50.4 / 1.547 = 32.58$ KSI ≈ 32.4 OK

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY FSNH-SEABROOK STATION UNITS 1 & 2
 STRUCTURAL CALCS-PIPE WHIP RESTRAINT
 SUBJECT _____

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	P.P.	Z.R.V.P.
FINAL	B-04-00-12		DATE 4.1.81	DATE 12.15.81.
VOID				
SHEET 56 OF		1	B.P.	A.P.
JO 9763-006			DATE 4-22-82	DATE 4-22-82

104 029

1W-49-30

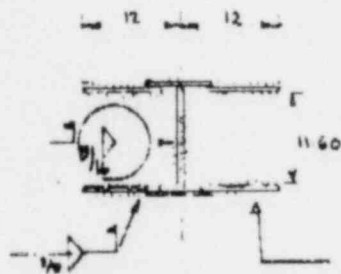
LINE RC. 29.1-14



5/16" WELD BETWEEN 3/8" STIFFENER & W16X77 :- NO LOAD ON STIFFENER,
 AS PER REVISED BLOW DOWN FORCE.

NOTE: AS PER AWS D1.1, 1/4" MIN. WELD SIZE FILLET WELD IS REQ'D.

WELD TO BASE PLATE.



$$\text{AREA OF WELD} = [(12-4.7+2.94) 4 + 2 \times 2] 0.707 \times 0.315 \times 98.12' + 11.60 \times 2 \times 0.707 \times 0.25 = 27.68 \text{ SQ IN}$$

$$\text{STRESS IN WELD} = 45.4 / 27.68 = 16.4 \text{ FOR COMP } < 32.5 \text{ O.I.}$$

$$= 386.5 / 27.68 = 13.96 \text{ FOR TENSION } < 32.5 \text{ O.I.}$$

1/2" GUSSET PLATE

10.24

$$\text{LOAD TRANSMITTED BY 12" PL} = 16.4 \times (12-4.7+2.94) 0.707 \times 0.315 \times 2 = 89 \text{ KIPS.}$$

$$\text{AVERAGE TOTAL LENGTH OF 3/16" WELD} = 9 \times 2 = 26 \text{ IN}$$

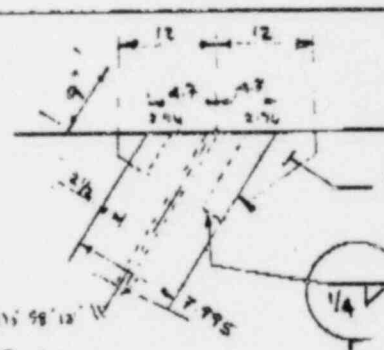
$$\text{STRESS IN 3/16" WELD} = 89 / 26 = 2.47 \text{ KSI} = \frac{2.47}{0.1875 \times 0.707} = 18.6$$

$$t_R \text{ W14x43} = 0.53 \text{ IN}$$



NOTE - AS PER AWS D1.1, (a) 1/4" MIN SIZE FILLET WELD
 IS REQUIRED (BETWEEN 1/2" GUSSET & FLANGE OF W14X43).
 MIN SIZE SHOWN ON DETAIL DWG.

(b) 3/16" MIN SIZE FILLET WELD REQ'D. BETWEEN WEB OF W14X43 &
 EMBEDMENT R. MIN SIZE SHOWN ON DETAIL DWG.



4.2.5 ANALYSIS OF PRR PW-49-4a

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	E R	ARW
FINAL	-8-04-00-12			
VOID				
SHEET <u>59</u> OF			DATE	DATE
JO 9763.006				

DWG No 104 029

PW-49-4a

LINE RC-49-1-14

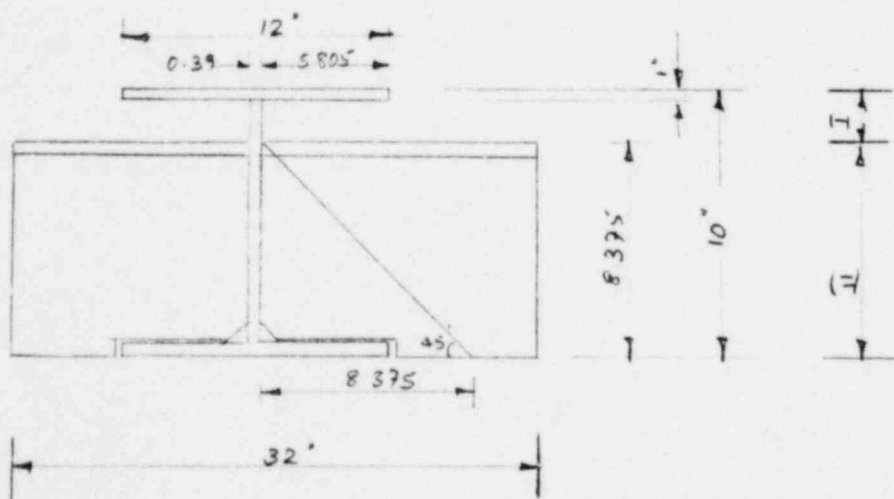
NOMINAL THICKNESS OF SHIM PLATES = $22.8125 - (7 + 9 + 1) = 5.8125$ IN
 DIMENSION 19" X 10"

MECHANISM OF LOAD TRANSFER

AT THE FIRST STAGE LOAD IS RESISTED BY WEB OF PC W12X65
 AS THE WEB STARTS TO DEFLECT, LOAD WOULD ALSO BE RESISTED
 BY THE WEB OF WT 7X141.5 DUE TO THE PRESENCE OF
 CONTINUOUS WELD - THE FLANGE AND WEB OF WT 7X141.5 WELDED TO WEB W12X65

1. LOAD TRANSFERRED BY AXIAL STRESS IN I STAGE

By AXIAL STRESS AND SHEAR STRESS IN I STAGE

AREA STAGE 1

EFFECTIVE LENGTH OF WEB = $19 + 1 + 1 = 21$
 WEB AREA = $21 \times 0.39 = 8.19$ SQ IN.
 STIFFENERS = $0.25 \times 5.805 \times 4 = 5.805$
 TOTAL = $8.19 + 5.805 = 13.995$ SQ IN.
 LENGTH = $10 - 8.375 = 1.625$ IN

FLEXIBILITY OR ELONGATION PER UNIT LOAD = $L/AE = \frac{1.625}{13.995 \times 29,000} = 4 \times 10^{-6}$ "/K. (1)

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S _____STRUCTURAL CALCS—PIPE WHIP RESTRAINT
SUBJECT _____

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	E.R.	AK
FINAL	-B-04-00-12		DATE 12.22.81	DATE 12.28.81
VOID				
SHEET 60 OF			DATE	DATE
JO 9763.006				

DWG 104 029

PW-49-4a.

LINE RC-49.1-14

II STAGE

$$\text{AXIAL LOAD AREA} = 13.995 \text{ SQ IN. (A)}$$

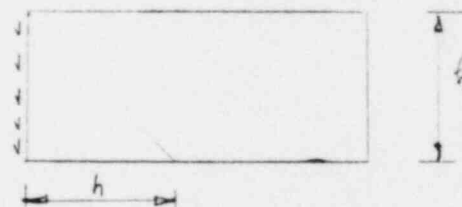
$$\text{SHEAR AREA} = 8.375 \times 1.29 = 10.8 \text{ SQ IN. (B)}$$

$$\text{LENGTH OF (A)} = 8.375 \text{ IN.} = \text{HEIGHT FOR COMPRESSION}$$

SHEAR LOAD TRANSMITTED AT 45°

$$\text{AVERAGE WIDTH OF DISTRIBUTION} = h/2 = 4.1875 \text{ IN.}$$

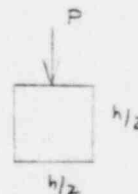
$$\text{AVERAGE HEIGHT} = h/2 = 4.1875 \text{ IN.}$$

SHEAR LOAD IS TRANSFERRED TO THE
MID POINT OF THE BLOCK $h/2 \times h/2$.MOMENT IS NEGLECTED. ONE BLOCK ON
EACH SIDE.

DEFLECTION FOR UNIT LOAD

$$= \frac{8.375}{13.995 \times E} + \frac{4.1875}{2 \times 4.1875 \times 1.29 \times E} = \frac{0.986}{E}$$

$$= 3.4 \times 10^{-5} \text{ IN/K. (2)}$$



$$\% \text{ COMBINED DEFLECTION (1) + (2)} = 4 \times 10^{-6} + 3.40 \times 10^{-5} = 3.8 \times 10^{-5}$$

$$\text{COMBINED STIFFNESS} = 1 / 3.8 \times 10^{-5} = 26315 \text{ K/IN}$$

DYNAMIC LOAD FACTOR

$$\text{DLF} = 1 + \left[1 + \frac{2 K \sigma}{F_B} \right]^{1/2}$$

$$= 1 + \left[1 + \frac{2 \times 26315 \times 0.1875}{277} \right]^{1/2}$$

$$K = \text{STIFFNESS} = 26315 \text{ K/IN}$$

$$\sigma = \text{HOT GAP} = 0.1875 \text{ IN}$$

$$F_B = \text{BLOW DOWN LOAD} = 277 \text{ K}$$

$$\text{DLF} = 7.05$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEAROOK STATION UNIT/S 1, 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	B.R.	A.R.
FINAL	-B-04-00-12			
VOID				
SHEET <u>61</u> OF			DATE	DATE
JO 9762-006				

104 029

PW-49-4a

LINE RC-49-1-14

$$\text{RESTRAINT LOAD} = 7.05 \times 277 = 1953 \text{ K}$$

$$\text{AREA STAGE I} = 13.995 \text{ SQ IN}$$

$$\text{AREA STAGE II} = 13.995 + 2 \times 4.1875 \times 1.29 = 24.80 \text{ SQ IN}$$

$$\text{STRESS IN AREA I} = 1953 / 13.995 = 139.5 \text{ KSI}$$

AREA I WOULD YIELD

CHECK FOR STRAIN.

$$\text{UNRESTRAINED LENGTH OF WEL OF W12X65} = 0.625 \text{ IN}$$

$$\text{RADIUS OF GYRATION } r = \sqrt{I/A} = \sqrt{\frac{b d^3 / 12}{6d}} = \frac{d}{\sqrt{12}} = \frac{0.39}{\sqrt{12}}$$

$$= 0.1125 \text{ IN}$$

$$Kl/r = \frac{2 \times 0.625}{0.1125} = 11.1$$

$$Kl/r < 25 \quad \therefore \text{BUCKLING NEED NOT BE CONSIDERED.}$$

$$\text{RESTRAINT LOAD AS CONTROLLED BY YIELD} = 13.995 \times 36 = 503.82 \text{ K}$$

$$\text{CONSIDERING SHIM THICKNESS } l = 1.625 + 5.8125 = 7.44$$

$$\text{EXTERNAL WORK DONE} = F_R (\delta_H + \delta_C + \delta_P) \quad \delta_H = \text{HOT GAP} = 0.1875$$

$$\text{INTERNAL STRAIN} = R_P \left(\frac{\delta_C}{2} + \delta_P \right)$$

$$\delta_C = \epsilon_C l = 1.24 \times 10^{-3} \times 7.44$$

$$= 9.23 \times 10^{-3} \text{ IN}$$

NEGLECTED.

$$277 (0.1875 + \delta_P) = 503.82 (\delta_P)$$

$$\delta_P = 0.229 \text{ IN}$$

$$\epsilon_P = \delta_P / l = 0.229 / 7.44 = 0.031 = \text{PLASTIC STRAIN.}$$

$$\text{TOTAL STRAIN} = 0.031 + 1.24 \times 10^{-3} = 0.032$$

$$E_U \text{ OF A-36 STEEL} = 0.20$$

$$\text{TOTAL STRAIN LESS THAN}$$

$$E_U / 2 \quad \text{O.K.}$$

$$\text{RESTRAINT LOAD} = 504 \text{ KIPO}$$

$$\text{STRESS IN STAGE II} = 504 / 24.80 = 20.32 \text{ KSI}$$

$$l = 8.375 - 2.07 - 1.3125 = 4.9925 \text{ IN} \quad Kl/r = 1 \times 4.9925 / 0.1125 = 44.38$$

$$F_{ue} = 0.66 [1 - 44.38 / (2 \times 126.1)] 36 = 22.29 \text{ KSI} \quad 720.32 \text{ KSI} \quad \text{O.K.}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF
COMPANY

PSNH—SEABROOK STATION

UNIT/S

STRUCTURAL CALCS—PIPE WHIP RESTRAINT
SUBJECT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	B.R.	AR
FINAL	-B-04-00-12		DATE 12.23.81	DATE 12.29.81
VOID				
SHEET	62 OF		DATE	DATE
JO	9763-006			

104 029

PW-49-4a

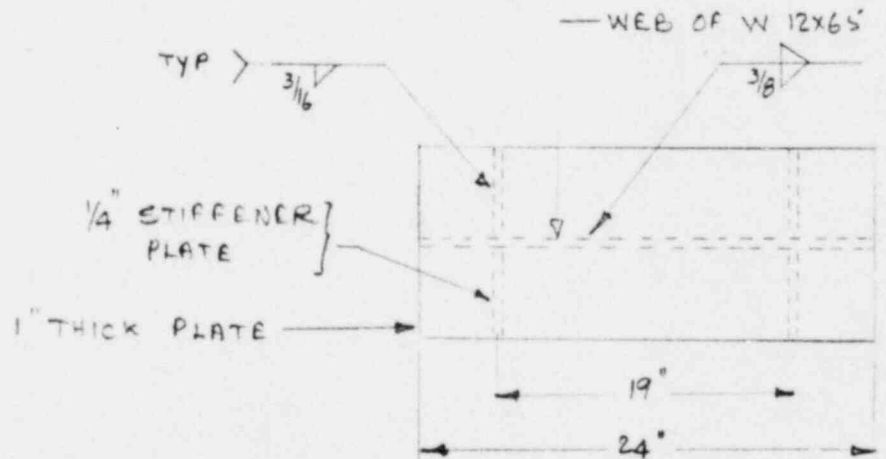
LINE RC-49.1.14^vWELD OF 1" PLATE WITH WEB OF PC W 12x65

EFFECTIVE LENGTH CONSIDERED = $24 \times 2 = 48"$
 + STIFFENER WELD LENGTH = $4 \times 5.805 = 23.22$ IN.

WELD AREA = $48 \times 0.375 \times 0.707 = 12.726$
 $+ 23.22 \times 0.1875 \times 0.707 = 3.078$
15.804 SQ IN.

STRESS IN WELD = $504 / 15.804 = 31.9$ KSI

THIS IS LESS THAN 32.4 KSI O.K.



PLAN OF CONNECTION
BETWEEN 1" PLATE AND WEB
AND PLATE & STIFFENER.

WELD BET. PC W 12x65 AND EMB PLATE

$\frac{1}{2}$ " ALL ROUND WELD
 PERIMETER = $(24 + 12) \times 2 = 72$ IN
 AREA = $0.5 \times 0.707 \times 72 = 25.452$ SQ IN
 STRESS IN WELD = $504 / 25.452 = 19.8$ KSI

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S _____
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	B.R.	AR
FINAL	-B-04-00-12		DATE 12-23-81	DATE 12-29-81
VOID				
SHEET	63 OF		DATE	DATE
JO	9763-006			

104029

PW-49-4A

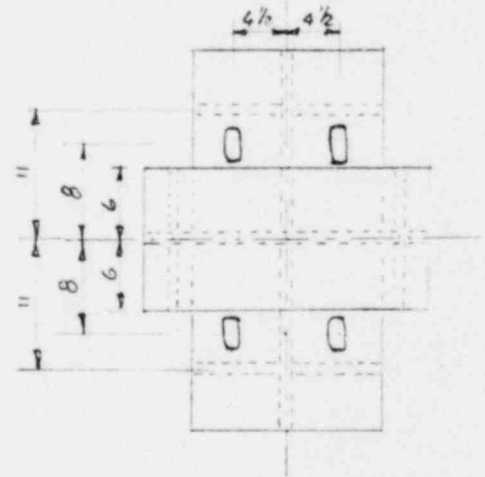
LINE RC-49-1-14

U-BOLT

MATERIAL A-36

LOAD ON U-BOLT 20% OF BLOW DOWN = $0.2 \times 277 = 55.4$ K

U-BOLT DIA = 1"

TENSION AREA OF 1" ϕ BOLT 2 IN = 0.606 SQ INSTRESS IN U-BOLT = $55.4 / (4 \times 0.606) = 22.85$ KSI < 36 O.K.CHECK FLANGE OF WT 7 x 141.5 FOR BENDING

CHECK AS CANTILEVER

MOMENT = $\frac{55.4 (4.5 \cdot \frac{1.29}{2})}{4} = 53.4$ K INFOR AN EFFECTIVE WIDTH OF 5" $S = 5 \times 2.07^2 / 6 = 3.57$ IN³STRESS IN FLANGE = $53.4 / 3.57 = 14.96$ KSI < 32.4 O.K.WELD OF WT 14 x 141.5 TO EMB PLATE

WELD SIZE = 3/8"

LENGTH = $2 (32 - 0.39) = 63.22$ INAREA = $63.22 \times 0.375 \times 0.707 = 16.76$ SQ INSTRESS IN WELD = $55.4 / 16.76 = 3.31$ KSI < 32.4 O.K.STRESS IN WEBTENSION = $55.4 / 2 = 27.7$ KIPSSTRESS = $27.7 / (5 \times 1.29) = 4.29$ KSI < 32.4 O.K.

4.2.6 ANALYSIS OF PRR PW-49-3b

GENERAL COMPUTATION SHEET

(DISCIPLINE)

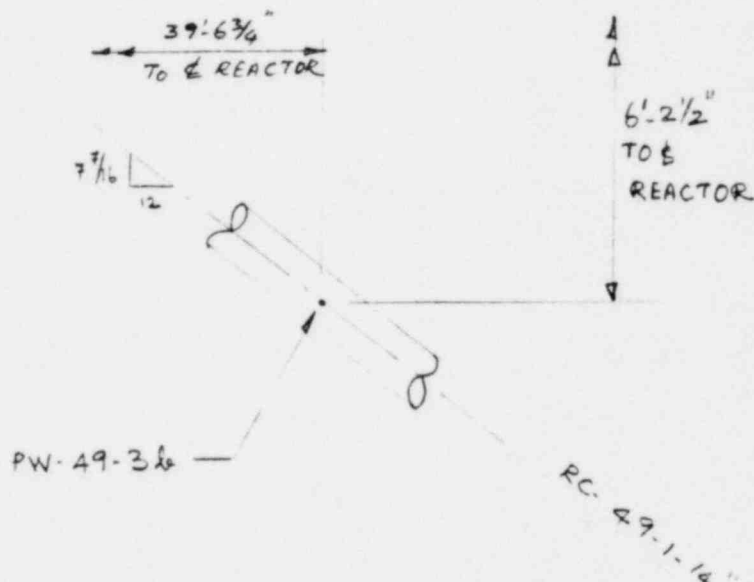
NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	S.R.	AK
FINAL	-8-04-00-12			
VOID				
SHEET 65A OF			DATE	DATE
JO 9763.006			12-1-51	12-16-51

104 030

PRR No PW-49-3b

LINE RC-49-1-14'

LOCATION PLAN PW-49-3b

BLOW DOWN FORCE = 277 KIPS VERTICAL UP/DOWN

Y - COLD GAP = 0

Y - HOT GAP = 0

b - COLD GAP = 2 1/4"

b - HOT GAP = 3/16"

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY **PSNH—SEABROOK STATION** UNIT/S _____
 SUBJECT **STRUCTURAL CALCS—PIPE WHIP RESTRAINT**

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	AR
FINAL	-8-04-00-12		DATE 12-1-81	DATE 12-16-81
VOID				
SHEET 66 OF			DATE	DATE
JO 9763-006				

104 030

PRR No—PW-49-36

LINE—RC-49-1-14'

BLOW DOWN FORCE = 277 K DOWNWARD
 NORMAL PRESSURE IN PIPE = 2.235 KSI
 INTERNAL DIA. OF PIPE = 11.19 in

Y—HOT GAP AT U-BOLT = 0
 Y—COLD " = 0

b—HOT GAP = 3/16"
 b—COLD " = 2 1/4"

STIFFNESS IN COMPRESSIONW 14 X 61 (1st STAGE)

A, AREA = 17.9 SI

EFFECTIVE LENGTH = 14 13.5 + 1.25 = 15.75" — ①

W 14 X 283 (2nd STAGE) AVERAGE AREA = (MIN + MAX)/2

AREA RESISTING COMPRESSION = AREA OF WEB + AREA OF STIFFENERS

AREA OF WEB (MIN) = $13.89 \times 1.29 = 17.92$ MAX = $[13.89 + 2 \times (16.74 - 11)] 1.29 = 32.73$ DISPERSION = $2 \times 2.07 = 4.14$

bf W14x283 : MAX WIDTH

STIFFENERS MIN AREA = $[(9.995 - 1.29) 0.75] \times 2 = 13.06$ MAX = $(16.11 - 1.29) 0.75 \times 2 = 22.23$ AVERAGE AREA = $(17.92 + 32.73 + 13.06 + 22.23)/2 = 42.97$ SQ IN. — ②

EFFECTIVE LENGTH

16.74 - 11 = 5.74

W 14 X 283 + PC W10 X 283 (3rd STAGE) AVERAGE AREA

WEB OF PC W 10 X 283 MIN = MAX AREA STIFFENER = 22.23

MAX = $(24 - 1.29) 1.29 = 29.30$

WEB OF W14x283 MIN = MAX ARE WEB ABOVE = 32.73

MAX = $30 \times 1.29 = 38.70$ AVERAGE AREA = $(22.23 + 29.30 + 32.73 + 38.70)/2 = 61.48$ SQ IN

EFFECTIVE LENGTH = 11 IN — ③

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1&2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM		0	BR	AR
FINAL	-B-04-00-12		DATE 12.1-81	DATE 12.16.81
VOID				
SHEET 66-A OF			DATE	DATE
JO. 9763-006				

104 030 PRR No. PW-49-3 & LINE RC-49-1-14

TOTAL DEFLECTION $\Delta_1 + \Delta_2 + \Delta_3 = 1"$ FOR $P = 644.4 \text{ K}$

$$\Delta_1 = \frac{P \times 15.75'}{17.9 \times E} = 0.88 \frac{P}{E}$$

$$\delta_1 = 0.0195"$$

$$\Delta_2 = \frac{P \times 5.75'}{42.97 \times E} = 0.134 \frac{P}{E}$$

$$\delta_2 = 1.81 \times 10^{-3}"$$

$$\Delta_3 = \frac{P \times 11}{61.48 E} = 0.179 \frac{P}{E}$$

$$\delta_3 = \frac{2.38 \times 10^{-3}}{0.0237} = \delta_0$$

$$1.193 \frac{P}{E}$$

$$\Delta_1 + \Delta_2 + \Delta_3 = 1" = \Delta$$

$$\Delta = 1 = 1.193 \frac{P}{E} ; P = K \cdot \text{STIFFNESS} = \frac{29 \times 10^3}{1.193} = 24.308 \times 10^3 \text{ K/IN}$$

DYNAMIC LOAD FACTOR

COLD GAP AT U-BOLT = 0

HOT GAP AT U-BOLT = 0

THERMAL MOVEMENT = 0

$$D\&F = 1 + \left[1 + \frac{2 \times K \sigma}{F_B} \right]^{1/2}$$

K = STIFFNESS OF SUPPORT

 σ = HOT GAP F_B = BLOW DOWN FORCE.

$$= 1 + \left[1 + \frac{2 \times 24.308 \times 10^3 \times 0}{277} \right]^{1/2} = 2$$

$$\text{RESTRAINT LOAD} = 277 \times 2 = 554$$

$$\text{STRESS IN } W14 \times 61 = 554 / 17.9 = 30.95 \text{ KSI}$$

$$\text{SLENDerness RATIO} = \frac{2 \times 15.75}{2.45} = 12.86 \text{ SHORT COL.}$$

$$F_y \text{ W14X61} = 2.45"$$

$$\text{ALLOWABLE STRESS} = 32.9 \text{ KSI} > 30.95$$

STRESS IN ALL OTHER COMPONENTS ARE LESS

O.K.

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 182SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP. BY	CHK'D BY
PRELIM		0	BE	AR
FINAL	8-04-00-12		DATE 12-1-81	DATE 12-16-81
VOID				
SHEET 67 OF			DATE	DATE
JO 9763.006				

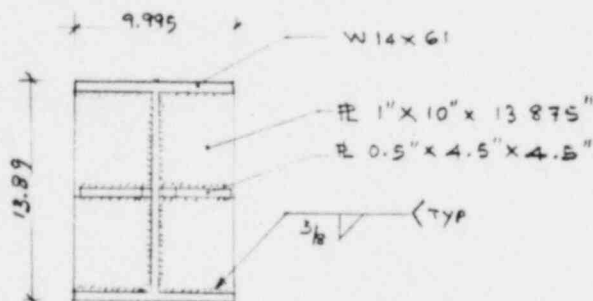
104030 PRR No. PW-49-36 LINE RC-49-1-14"

CHECK PLATE (SEE SKETCH BELOW)

LOADING INTENSITY = $554 / (12.875 \times 9) = 4.78$ KSI SHIM PLATE $12\frac{7}{8} \times 9$
 PLATE (APPROXIMATED TO) FIXED ONE EDGE, SIMPLY SUPPORTED 2 EDGES & FREE 4TH
 REF. FORMULAS FOR STRESS & STRAIN BY ROARK. CASE 7
 $a = (13.89 - 2 \times 0.645 - 0.5) / 2 = 6.05$ IN $b = (9.995 - 0.375) / 2 = 4.81$ IN
 $a/b = 6.05 / 4.81 = 1.258$; $\beta_1 = 0.983$ $\beta_2 = 0.65$
 IF PIPE IS IN PLACE SHIM = 3". MIN SHIM THICKNESS = 1"
 \therefore TOTAL EFFECTIVE THICKNESS OF PLATE = 2 IN

$$\text{MAX STRESS} = 0.983 \times 4.78 \times 4.81^2 / 2^2 = 27.18 \text{ KSI} < 32.4 \text{ KSI}$$

OK

WELDINGWELD BET. W14x61 & $12\frac{7}{8} \times 9$ SHIM

$$\begin{aligned} \text{WELD LENGTH } 9.995 - 0.375 &= 9.62 \\ 13.89 - 2 \times 0.645 &= 12.60 \\ 4.5 \times 2 + 0.5 &= 9.50 \\ \hline 21.72 \times 2 &= 43.44 \end{aligned}$$

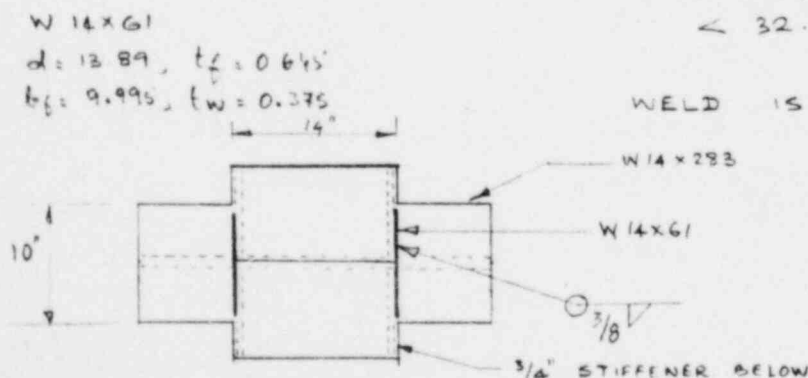
$$\text{FOR } 3/8" \text{ FILLET WELD } = 0.707 \times \frac{3}{8} \times 32.4$$

$$\text{CAPACITY} = 8.59 \text{ KLI}$$

$$\text{WELD STRESS} = 554 / (43.44 \times 0.707 \times 0.375) = 32.3 \text{ KSI}$$

$$< 32.4$$

WELD IS ADEQUATE



WELD BET W14x61 & W14x283 (SEE SKETCH ABOVE)

 $3/8"$ ALL ROUND WELD

$$\text{TOTAL WELD} = 2[9.995 + (9.995 - 0.375) + (13.89 - 2 \times 0.645)] = 64.43"$$

SUFFICIENT WELD AS COMPARED WITH THE ABOVE.

$$\text{STRESS} = \frac{61.40}{64.43} \times 34 = 32.42 \text{ KSI}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1.2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM		0	ER	AR
FINAL	8-04-00-12		DATE 12-1-81	DATE 12-16-81
VOID				
SHEET 68 OF			DATE	DATE
JO 9763-006				

104 030

PRR No PW-49-36

LINE RC-49-1-14"

3/4" STIFFENER BETWEEN W14X61 & PCW14X283

$$\text{EFFECTIVE AREA TO RESIST COMPRESSION} = \frac{(9.995 - 1.29 + 2 \times 2.07) \times 0.75 \times 2}{12.845} = 19.27 \text{ IN}^2$$

$$\text{STRESS IN W14X61} = 30.95 \text{ KSI}$$

$$\text{AREA OF FLANGES} = 9.995 \times 0.645 \times 2 = 12.89 \text{ IN}^2$$

$$\text{FORCE IN FLANGE} = 30.95 \times 12.89 = 398.9 \approx 400 \text{ K}$$

FLANGE OF W14X61 RIGHT OVER 3/4" STIFFENER. FLANGE LOAD DIRECTLY FLOWS INTO 3/4" STIFFENER

$$\sigma \text{ STRESS IN STIFFENER} = 400 / 19.27 = 20.76 \text{ KSI}$$

$$I = 12.845 \times 0.75^3 / 12 = 0.452 \quad A = 12.845 \times 0.75 = 9.63 \quad (I/A)^{1/2} = (0.452 / 9.63)^{1/2} = 0.217$$

$$K_{RT} = 1 \times (16.79 - 11.207) / 0.217 = 16.9 < 25 \quad F_c = 32.4 \text{ KSI}$$

3/8 WELD OF STIFFENER

$$\text{ACTUAL WELD LENGTH PER SIDE} = 16.11 - 1.29 = 14.82 \text{ IN}$$

$$\text{CONSIDERING ONLY } 9.995 - 1.29 + 2 \times 2.07 = 12.845 \text{ IN}$$

$$\text{TOTAL WELD LENGTH} = 12.845 \times 4 = 51.38 \text{ IN}$$

$$\text{STRESS} = 400 / 51.38 = 7.785 \text{ KSI} = 29.364 \text{ KSI} < 32.4 \text{ O.K.}$$

3rd STAGE AREA PCW14X283 AND W14X283 (ONLY WEB FOR BOTH)

$$\text{MIN AREA OF WEB OF PCW14X283} = 22.23 \text{ IN}^2$$

$$\text{LOAD OF 3/4" STIFFENER TRANSMITTED} \quad P_c = 400 \text{ K}$$

$$\text{STRESS} = 400 / 22.23 = 17.99 \text{ KSI}$$

WELD

$$\text{LENGTH OF 3/8" WELD} = (16.11 - 1.29 - 2 \times 0.5) \times 4 = 55.28$$

(2 - WEBS, BOTH SIDES)

$$\text{EFFECTIVE AREA} = 0.707 \times 0.375 \times 55.28 = 14.66 \text{ SQ IN}$$

$$\text{LENGTH OF 1/2" WELD} = [24 - 2(3.25 + 6.75)] \times 2 = 8$$

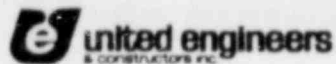
$$\text{AREA} = 2 \times 0.707 \times 0.5 = 2.828$$

$$\text{TOTAL AREA} = 14.66 + 2.83 = 17.49 \text{ SQ IN}$$

$$\text{WELD STRESS} = 400 / 17.49 = 22.87 < 32.4 \text{ O.K.}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)


 NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1,2

 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM			<u>B.R.</u>	<u>AR</u>
FINAL	<u>-B-04-00-12</u>	0	DATE <u>12-1-81</u>	DATE <u>12-1-81</u>
VOID				
SHEET <u>69</u> OF			DATE	DATE
JO <u>9763 006</u>				

104.030'

PW-49.36

LINE RC-49.1-14"

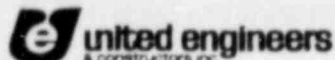
WELD OF W14x283LOAD ON W14x283 \approx TOTAL LOAD = 554 KIPS
$$\text{WELD PROVIDED} = 2 \times 30 \times 0.707 \times 0.5 + 2 \times 16.11 \times 0.707 \times 0.375$$

$$= 29.75 \text{ SQ IN.}$$

$$\text{STRESS IN WELD} = 554 / 29.75 = 18.62 \text{ KSI} < 32.4 \text{ O.K.}$$

GENERAL COMPUTATION SHEET

(DISCIPLINE)



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 2
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO.		REV	COMP BY	CHKD BY
PRELIM		0	BR	LR
FINAL	-8-04-00-12		DATE 12.1.81	DATE 12.16.81
VOID				
SHEET 70 OF			DATE	DATE
JO 9733.006				

104 030

PW-49-26

LINE RC-49-1-14"

U-BOLT ANALYSIS

HOT GAP AND COLD = 0
 BLOW DOWN FORCE = 277 K

MATERIAL OF U-BOLT
 A-276 XM-11
 $f_y = 50 \text{ KSI}$ $f_u = 80 \text{ KSI}$
 $\epsilon_u = 45\%$
 $E = 1.724 \times 10^5$

DYNAMIC LOAD FACTOR, DLF = 2 AS HOT GAP = 0

RESTRAINT LOAD, $R_p = 2 \times 277 = 554 \text{ KIPS}$ SHANK DIA OF U-BOLT = $1\frac{1}{2}$ " ; $A_g = 1.767 \text{ SQ IN.}$

STRESS IN U-BOLT = $554 / (4 \times 1.767) = 78.38 \text{ KSI}$
 U-BOLT WOULD YIELD.

 $R_p = 4 \times 1.767 \times 50 = 353.4 \text{ K}$

CHECK U-BOLT FOR ELONGATION.

LENGTH OF U-BOLT OF DIA IS IN (REF U-BOLT DETAIL B IN DWG)
 = $41\text{'-}11\text{'}$ = 30 IN.

$$F_b (\sigma_H + \delta_E + \delta_P) = R_p \left(\frac{\delta_E}{2} + \delta_P \right)$$

σ_H = HOT GAP = 0
 δ_E = ELASTIC ELONGATION
 $= \epsilon_E l = 1.724 \times 10^{-5} \times 30$
 $= 0.051 \text{ IN.}$

$$277 (0 + 0.051 + \delta_P) = 353.4 (0.051/2 + \delta_P)$$

$$14.127 + 277\delta_P = 9.1353 + 353.4\delta_P$$

$$\delta_P = 0.067 \text{ IN.}$$

$$\epsilon_P = 0.067 / 30 = 2.24 \times 10^{-3}$$

$$\epsilon = \epsilon_E + \epsilon_P = 3.964 \times 10^{-3} < 0.225 \quad \text{O.K.}$$

THREAD

THREAD DIA = 1.75 SQ IN. NO OF THREADS PER INCH = 8

TENSION AREA = $0.485 (1.75 - \frac{0.974}{8})^2 = 2.08 \text{ SQ IN.} = A_T$ RATIO OF SHANK AREA TO THREAD AREA = $1.767 / 2.08 = 0.85$

U STRESS IN THREAD IS $0.85 \times$ STRESS IN SHANK
 NEGLECTING STRESS CONCENTRATION. = $0.85 \times 50 = 42.5 \text{ KSI}$

(DISCIPLINE)

GENERAL COMPUTATION SHEET



NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S
 SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHKD BY
PRELIM				
FINAL	-8-04-10-12	0		AL
VOID				
SHEET	71 OF			
JO. #	442-101			
		1	B.R.	11P
			DATE 4.22.82	DATE 11.11.81

104 030

REV. 01 12-10-81

PC-47.1-14

CHIEF ENGINEER TO ASSESS U-KOLT LOAD SHEET FROM PC

LOAD PER LEG OF U-KOLT = $354 / 4 = 88.5 \text{ K}$

CANTILEVER EFFECTIVE SPAN = $3.4925 - 1.29 / 2 = 2.8475 \text{ IN}$
 EFFECTIVE WIDTH = $6.75 - 0.5 = 6.25 \text{ IN}$

EFFECTIVE SIMPLY SUPPORTED SPAN = 6.75 IN WIDTH = $2.8475 + 4.5025 = 7.41 \text{ IN}$

TOTAL LOAD $P = 88.5 \text{ KIP}$

LOAD RESISTED BY SIMPLE BEAM = kP , BY CANTILEVER = $(1-k)P$

DEFLECTION OF CANTILEVER = $\frac{(1-k) \times 2.8475^3 P}{3EI}$ $I_1 = 6.25 \times 2.07^3 / 12 = 4.62 \text{ IN}^4$

DEFLECTION OF S.S. BEAM = $\frac{kP \times 6.75^3 \times 2.5}{3EI}$ $I_2 = 7.41 \times 2.07^3 / 12 = 6.68 \text{ IN}^4$

EQUATING DEFLECTIONS $\frac{(1-k) 2.8475^3}{3EI_1} = \frac{k \times 6.75^3 \times 2.5}{3EI_2}$

$$(1-k) 4.997 = 2.498 k$$

$$\text{OR } k = 0.59$$

LOAD IN S.S. BEAM = $0.59 \times 88.5 = 52.2 \text{ KIPS}$

LOAD IN CANTILEVER = $0.41 \times 88.5 = 36.3 \text{ KIPS}$

MOMENT IN S.S. BEAM = $52.2 \times 3.5 \times 2.5 / 6.75 = 87.97 \text{ KIN}$

CANT. MOMENT = $36.3 \times 2.8475 = 103.36 \text{ KIN}$

STRESS = $\frac{103.36 \times 1.04}{4.62} = 23.27 < 32.4 \text{ O.K.}$

STIFFENER $\frac{1}{2}$ "

LOAD ON STIFFENER = $52.2 \times 3.5 / 6.75 = 27.1 \text{ K}$ TENSION

STIFFENER STRESS = $27.1 / (7.41 \times 0.5) = 7.31 \text{ KSI} < 32.4 \text{ O.K.}$

WELD = $\frac{3}{8}$ " $A = 0.375 \times 24.7 \times 2 \times 7.41 = 3.93 \text{ SQIN}$

WELD STRESS = $27.1 / 3.93 = 6.89 \text{ KSI} < 32.4 \text{ O.K.}$

NOTE: AS PER AWS D11, $\frac{5}{16}$ " MINIMUM SIZE FILLET WELD REQ'D. FOR 3RD SIDE. MIN SIZE SHOWN ON DETAIL DWG

WELD OF PC W/ 283

LOAD ON WELD & CANTILEVER WELD = 36.3 K

STRESS = $36.3 / (6.75 \times 1.04) = 4.53 \text{ KSI}$

WELD AT BOTTOM = $0.375 \times 0.707 \times (10.11 - 2 \times 0.5) \times 2 = 8.01 \text{ SQIN}$
 STRESS = $36.3 / 8.01 = 4.53 \text{ KSI}$

GENERAL COMPUTATION SHEET

(DISCIPLINE)

NAME OF COMPANY PSNH—SEABROOK STATION UNIT/S 1, 2SUBJECT STRUCTURAL CALCS—PIPE WHIP RESTRAINT

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM			B.E	AR
FINAL	-B-04-00-12	0	DATE 12 3 87	DATE 12 16 87
VOID				
SHEET 72 OF			DATE	DATE
JO 4763.006				

104 030

PW-49-36

LINE RC-49-1-14

W14 x 283

LOAD TRANSMITTED THROUGH BOTTOM FLANGE WELDED TO THE EMB PLATE.

AREA OF 1/2" WELD = $0.5 \times 0.707 \times 2 \times 30 = 21.21$ SQ INAREA OF 3/8" WELD = $0.375 \times 0.707 \times 2 \times 16.11 = 8.54$

TOTAL

: 29.75

WELD STRESS = $334 / 29.75 = 11.9$ KSI < 32.4 O.K.

5.0 REFERENCES

1. AISC Specifications for Steel Construction Manual.
2. U.S. Nuclear Regulatory Commission - Standard Review Plan, Section 3.6.2.
3. Formulas for Stress and Strain by R.J. Roark.
4. Memorandum # MM-7457 A (Date: 7-29-81).
5. Memorandum # MM-7158 A (Date: 5-19-81).
6. ASME Boiler and Pressure Vessel Code III.